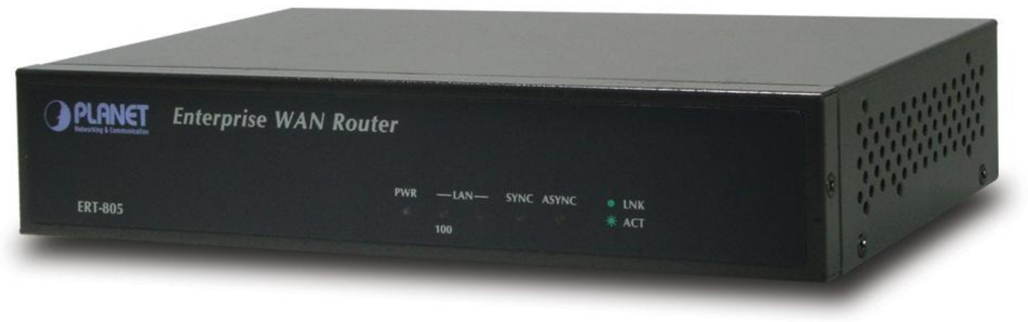
Serial WAN Router

ERT-805

User's Manual



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FCC Warning

his equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the Instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CE Mark Warning

This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

Revision

PLANET Enterprise Serial Router User's Manual

FOR MODELS: ERT-805

Part No.: EM-ERT805

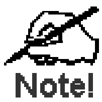
TABLE OF CONTENTS

Chapter 1 Introduction

1.1 Checklist

Thank you for purchasing Planet's ERT-805 Enterprise Serial Router. Before continuing, please check the contents of your package for following parts:

- Ø ERT-805 Serial WAN Router
- Ø Power Cord
- Ø DB9 adapter
- Ø RJ-45 to RJ-45 modem cable
- Ø User's Manual CD
- Ø Quick installation Guide



if any of these pieces are missing or damage please contact your dialer immediately.

1.2 About ERT-805

ERT-805 provides single WAN port, which is T1/E1 serial interface, single LAN port, and single console (Async) port.

With IPSec/VPN capability, the ERT-805 not only being a standard router but also can be a router with feature-enhanced security. ERT-805 is supports MD5-HMAC/SHA1-HMAC and certificate authentication, DES-CBC and 3DES-CBC encryption.

The other capabilities that ERT-805 provides are NAT, Access-list, AAA security, CBAC firewall and QOS. With these functions ERT-805 is efficiency and secure network device.

User interface

ERT-805 is only able to use command line interface (CLI) to configure.

Protocol and routing

- Ø ERT-805 supports few WAN protocols on its WAN port: PPP, HDLC, SDLC, frame-relay, LAPB and X.25.
- Ø Support static and dynamic routing protocol: static route, RIP, EIGRP and OSPF

Network Management

- Ø Connect PC to ERT-805 through network and run Telnet to manage it through command line interface

- ERT-805 supports SNMP and can be managed by using SNMP management software

1.3 Product Feature

- Support PPP, FR, X.25, HDLC, LAPB, SDLC, SLIP and Stun
- Complies with IEEE802.3 10Base-T, IEEE 802.3u 100Base-TX Standard
- One serial WAN port, one RJ-45 10/100Mbps LAN port and one Console port
- Provide RIP, EIGRP, OSPF and Static routing protocol
- Provide Access-list, AAA, RADIUS, PAP, CHAP and CBAC for network security
- Network Address Translator (NAT) simultaneous use of one IP address
- Provide IPSec (DES/3DES), IKE and GRE for VPN
- DHCP Serve with dynamic IP assignment for LAN port
- Provide QOS to increase network efficiency
- Provide WFQ, priority queuing and custom queuing to increase network performance

1.4 Product Specification

Model	**ERT-805**
Device Specification	
LAN	1 x 10/100Base-TX (RJ-45)
WAN	1 x Serial Port (DB-25)
Console	1 x RJ-45
LED	5; Power, LAN Speed, LAN Link/Activity, WAN and Console Link/Activity
Network standard	IEEE802.3, 10Base-T, IEEE802.3u, 100Base-TX
Router OS Operation	
Communication	PPP, frame-relay, X.25, PPPOE. HDLC, SDLC, SLIP and LAPB
Security	ACL, NAT, AAA RADIUS, PAP, CHAP and CBAC
Route protocol	RIP V1 and V2, CDP, OSPF, EIGRP and Static
VPN	IPSEC and IKE, GRE
Queue/QOS	WFQ, CQ, priority queuing and rate-limit. Class-map and policy-map
Application	DHCP server, PING, Trace Route, telnet, TFTP
Management	Telnet, Console
Throughput	2Mbps
Environment / Hardware Specification	

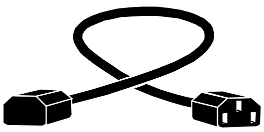
Power Input	100 ~ 240V AC (+/-10%); 50/60Hz (+/-3%) auto-sensing
Power Consumption	10 watts / 34BTU
Dimensions	217 x 135 x 43 mm (1U height)
Weight	1 Kg
Temperature	0 to 50 degree C (operating) -20 to 70 degree C (storage)
Humidity	10 ~ 90% RH (non-condensing)
Regulatory	FCC, CE class A

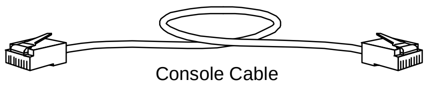
Chapter 2 HARDWARE INSTALLATION

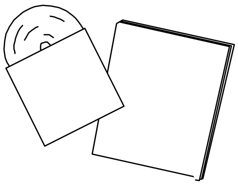
2.1 Package Contents

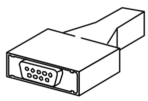
Item includes with ERT-805 serial router.

- ERT-805 Serial WAN Router
- Power Cord
- DB9 to RJ-45 changer
- Console cable
- Quick Installation Guide and CD-ROM


Black power cord

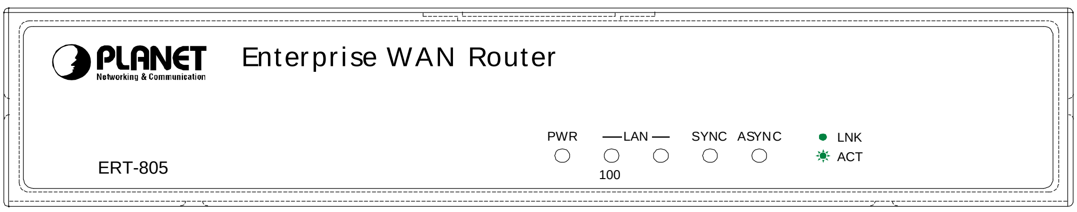

Console Cable


CD-ROM user's Guide &
Quick Install Guide


DB-9-to-RJ-45 adapter
(for Console Cable)

2.2 ERT-805 outlook

2.2.1 Front Panel

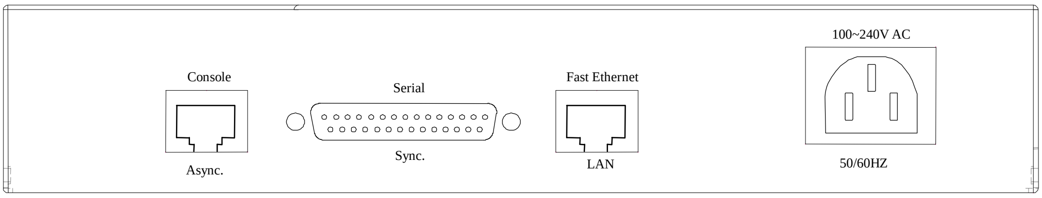


LED definition

LEDs		State	Indication
PWR (Power)		Green	Power on when 100~240VAC power attached
		Lights Off	No power
LAN	100	Green	This indicator light for Fast Ethernet connection

	LNK/ ACT	Green blink	This indicator light blink when packets is transmit
		Green	This indicator light green when port is connected
Serial		Green	This indicator light green when port is connect with serial port
		Blink	This indicator light blink when packets is transmit
Console		Green blink	Configuration process
		Lights Off	Not in configuration

Rear Panel



Printing	Ports Type	Description
Console	RJ-45	Asynchronies port of ERT-805. Allows the connection to a terminal device or PC for management or asynchronize dialing.
Serial	DB-25	Synchronies port of ERT-805. Allows the connection with a Synchronize/ Asynchronize device like CSU/DSU modem
Fast Ethernet	RJ-45	Fast Ethernet interface of ERT-805. Allows to connect to a Ethernet hub/switch through Category 3 or above UTP cable.
100~240VAC	Power socket	The power socket of ERT-805. The allowed power input is range from 100VAC to 240VAC (+/-10%), 50/60Hz (+/-3%), auto-sensing

M

Warning!

The two RJ-45 ports of ERT-805 are not a telephone port. Connect to a telephone wire or PSTN line to the ports may cause the router permanently malfunction.

Note!

Serial cable is not bundled together with the router, please consult your local dealer for the available serial cable for your CSU/DSU modem.

2.3 Installation requirements & Physical Installation

To install the ERT-805 serial router, the following is required:

Ø An Ethernet device, hub or switch with a free MDI-X RJ-45 interface

Ø One Category 3, 4, 5, EIA568A straight UTP cable within 100 meters

Ø The asynchronous modem or CSU/DSU (Channel Service Unit/Data Service Unit) that is planned to connect the router

Ø A serial cable that used to connect the router and the CSU/DSU

Ø Rack mount accessories, such as rack ears, screws, and screws driver

Ø A standalone PC or terminal device with a free COM interface

Note!

> The serial cable and rack ears do not ship with the router, pleas consult your local dealer for the information.

To install ERT-805 serial router, just following the steps:

Ø Device placement

Ø Connect a Ethernet device

Ø Connect a Serial device

Ø Connect the power supply

Ø Connect a terminal or PC for management

2.3.1 Device placement

The ERT-805 is a 1-U height, 10-inch rack-mountable device that can fit to 10-inch cabinet or 19-inch cabinet. Please consult with your local dealer for the available rack ear if you would to install the router into a 10-inch/19-inch shelf.

You can also place the ERT-805 on the desktop, please install the router in a clean, dry environment. Avoid install the router in a place with moisture and water around/near-by.

2.3.2 Connect to a Ethernet device

The ERT-805 is with one Fast Ethernet MDI (media dependent Interface) port. This RJ-45 interface an direct connect to any Ethernet or Fast Ethernet hub or switch with MDI-X port through Category 3 or above, 2-pair straight UTP cable. The maximum distance for the cable should below 100 meters.

Connect to an Ethernet device with MDI interface, a cross-over cable is required.

2.3.3 Connect to a Serial Device

The ERT-805 is with one synchronize interface that can connect with CSU/DSU with up to E1 line rate.

Available connection is as tables below:

WAN Option	WAN Encapsulation
RS-232	Link control (HDLC) or ppp
X.21	Frame-relay
V.24	X.25
V.35	

2.3.4 Power on the device

ERT-805 accepts power input from 100 to 240VAC, 50/60Hz power source. Before connect the power cable to the router, please be sure the AC power output from your power outlet. The router must connected to earth ground during normal use.

Note!

ERT-805 is a power-required device, it means, ERT-805 will not work until it is powered. If your network and the router will need to transmit data all the time, please consider use an UPS (Uninterrupted Power Supply) for your router and the connected Ethernet Devices. It will prevent you from network data loss.
In some area, installing a surge suppression device may also help to protect your router from being damaged by unregulated surge or current to the Switch or the power adapter

Chapter 3 Command Line Interface

This chapter describes the basic commands to access the router through console interface or telnet. Be noted if you want to login to ERT-805 through the telnet, then **enable password** must be configure.

The user can input system command configuring system protocol by command line port. When you first login a new router by terminal, the system will give a prompt router>. Now you are in user mode. After typing the command "enable", the prompt will change to router#, and now you are in privilege mode so that you could input more commands including some privilege command. To enter the global configuration mode, you should type the command "configure terminal" or "config T". Then the prompt will change to router(config)#, and you could input global configuration commands configuring the parameter of the router. If you type the command "interface serial 0/0" or "int s0/0",you will notice that the prompt change to router(config-serial0/0)# and then you are in port configuration。

Prompt	Mode
Router**>**	Normal User mode
Router#	Enable mode for privilege operation
Rouer**(config)#**	Configuration mode
Rotuer**(config-serial0/0)**	Configuration mode of object control

Table for different configure mode

In different configuration mode, the system will give different prompt, and every configuration mode has its due commands collect. From the prompt you could know what configuration mode you are in. The left most word of the prompt is the name of the router, from which you can know that which router you are configuring. You can set the hostname of the router with the **hostname** command as below:

```
router# config terminal
Enter configuration commands, one per line. End with CNTL/Z.
router(config)# hostname ERT_805
ERT_805(config)# exit
ERT_805#
```

3.1 Help command

"?" and "Tab" keys are two help keys that help user to configure ERT-805. By using a "?" key in different operate mode, the system will display the help message that tell user what command they can use in different operate mode. For example:

```
ERT_805> ?
disable      Turn off privileged commands, enter GUEST user mode
enable       Turn on privileged commands
exit         Exit from the EXEC
help         Description of the interactive help system
logout       Exit from the EXEC
pad          Open a X.29 PAD connection
ping         Send echo messages
ppp          Start IETF Point-to-Point Protocol (PPP)
schedule     Schedule one task
show         Show running system information
telnet       Open a telnet connection
traceroute   Trace route to destination
tty          Print current tty information
ERT_805>
```

“**Tab**” is another help key, when user typing a word if from the letters you’ve typed the system could identify the word you want to type, press the tab key then, the system will complete the word for you automatically.

3.2 Redisplay Previous command

The system saves the inputted commands in a history table, so that you could input the command again by it. Just simply press ↑ key and ↓ key or ctrl + P or Ctrl + N.
You could verify the commands in the history table by the command show history

3.3 Verify Current Configuration

The system offered two special hotkeys Ctrl-Q and Ctrl-O with which you could verify your configuration any time. In privilege mode, global configuration mode or port configuration mode, the system will display the current configuration right now if you press Ctrl-Q as if you’ve pressed show run. It means that you needn’t go back to privilege mode to verify your configuration. The hotkey Ctrl-O is available only in port configuration mode. At anywhere even when typing a command, if you press the hotkey Ctrl-O, the system will show you the configuration message of the current port, and then you could go on with your command. This hotkey avoids the condition that when need verifying the configuration message you have to quit and enter the port configuration mode again and again. When configuring the routing protocol you could use the hotkey Ctrl-O as well.

```
ERT_805(config-serial0/0)#
% CONFIGURATION OF CURRENT OPERATING OBJECT
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  crypto map dynmap
```

```
  clockrate 48000
!
ERT_805(config-serial0/0)#
```

3.4 Ctrl-Z, Ctrl-C and exit

To exit from the configuration mode directly to privilege mode, you should type Ctrl-Z or Ctrl-C or type exit. Ctrl-C can be available in other occasions .For example it can stop the current operation that hasn't been accomplished.

3.5 Login from Console port

Once the terminal has connected to the device, power on the device, the terminal will display that it is running POST (Power on self-test) procedures.

Then, screen as below will show up. The ERT-805 will prompt with ">". This means ERT-805 is in operating mode now.

Types "**enable**" to enter privilege mode. The ERT-805 will prompt with "#" for privilege mode. By default there is no password.

```
Router Software Version 4.2c on Hex_1f73  (3805a)

User Access Verification

Password:
ERT_805> enable
Password:
ERT_805#
```

3.6 Virtual Terminal Access

The router allows being accessed from network by telnet, therefore you could configure and maintain the router by network. Please to note, if the router hasn't set a password for entering privilege mode, the router will forbid the network users from entering privilege mode.

```
ERT805> enable
% Password is not set, you are not allowed to enter privileged mode.
```

Before login ERT-805 by telnet you must set the password by command "enable password" in global configuration mode. After that router will allow you're entering the privilege mode by telnet. If configures like below, the system will only ask for password when anyone access. For example set the password as "1234".

```
ERT805> enable
ERT805# config t
ERT805(config)# enable password 1234
ERT805(config)#line vty 0 4
ERT805(config-line)# login
ERT805(config-line)# password cisco
ERT805(config-line)# exi
ERT805(config)# exit
ERT805#
```

The password is set by the command "**password**" in vty and has no concern with what have been configured above by the command username. The following example shows the result that configure on above.

```
Router Software Version 4.2c on Hex_1f73  (3805a)

User Access Verification

Password:
ERT_805> enable
Password:
ERT_805#
```

The other method is force the network user to verify his username and password. For example

```
ERT805# config t
Enter configuration commands, one per line. End with CNTL/Z.
ERT805(config)# username rr password cisco
ERT805(config)# line vty 0 5
ERT805(config-line)# login local
ERT805(config-line)# exit
ERT805(config)# exit
ERT805#
```

The following example shows the result that configure on above:

```
Router Software Version 4.2c on Hex_1f73  (3805a)
User Access Verification
Username: rr
Password: (type the password cisco)
ERT805>
```

3.7 Password Encryption

Security is a most important issue for all the company in the world because all the system is require password to protect important information from hacker, such as username, enable password…etc. In default the system will display these password by clear. So the password is not very secure. The ERT-805 is offers a command that make the system display the password by cryptograph. For example:

```
ERT_805# show run
Building configuration ...
description fault
service password-encryption
service timestamps debug
!
hostname ERT_805
!
enable password 7 3EDRIxtqRWCA
!
username router password 7 65WeJR6evnrR3mP
crypto ipsec transform-set transform-1 esp-3des esp-md5-hmac
!
crypto map dynmap 1 ipsec-isakmp
  set transform-set transform-1
  set peer 10.0.0.2
  match address 100
!
crypto isakmp policy 1
  authentication pre-share
  group 1
  hash md5
!
```

```
crypto isakmp key 12345678 address 10.0.0.2 255.255.255.192
!
interface fastethernet 0/0
 ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
 encapsulation ppp
 ip address 10.0.0.1 255.255.255.192
 crypto map dynmap
 clockrate 48000
!
interface async 0/0
!
line vty 0 5
 login
 password 7 wAVcXxom8sGSOA
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 192.168.98.0 0.0.0.255
!
end

ERT_805#
```

Chapter 4 Router Communication Protocol

4.1 RIP- Router Information Protocol

The routing information Protocol (RIP) is a distance-vector protocol that used to exchange routing information between routers. RIP uses broadcast User Datagram Protocol (UDP) data packets to exchange routing information and rip is based on distance-vector algorithm. This routing protocol is determines the best path through an Internet by looking at the number of hops between the two end nodes. The maximum hops count for RIP is 15 hops.

4.1.1 Routing loops

There is problem with distance-vector routing protocol, which is router cannot acquaint with the whole status of network. Routers have to get network reachable information depending on neighboring routers and RIP also comes up against slow convergence, which will introduce inconsistence. The following methods that used by RIP to decrease possibility of routing loop: **spilt horizon, spilt horizon with poison reverse, Holddown timer** and **triggered update.**

4.1.1.1 Spilt Horizon

The spilt horizon is a technique for preventing reverse routes between two routers. The rule of spilt horizon is that router never advertised the cost of a destination to neighbor if it is the current next-hop for the destination.

4.1.1.2 Spilt Horizon with Poison Reverse

The rule for “split horizon” is when sending updates out a particular interface, designate any networks that were learned from updates received on that interface as unreachable. This mean is when an interface is up; the router records from which interface a route comes, and not sends the route back to this interface.

4.1.1.3 Holddown timer

Holddown timer is able to prevent a router from receiving new routing information that was just removed from routing table. The default holddown timer is 180 seconds.

4.1.1.4 Triggered update

Split horizon with poisoned reverse will break any loop of two routers. However, it is still possible for loops of three or more routers, to occur. This loop will break only when infinity (presented as 16) will be reached. Triggered updates are an attempt to speed up this convergence. Whenever a router changes the metric of a route, it is required to send update messages almost immediately

4.1.1.5 RIP Command

router rip – enable rip in global configuration mode

version - To specify a RIP version used globally by the router (version 1 and 2)

auto-summary – enable automatic network number summarization.

Network – Enable routing on an IP network

Neighbor – specify a neighbor router

Bind-interface – Enable RIP protocol on some interface

Default-metric – set metric of redistributed routes

Distance – define an administrative distance

Distribute-list – Filter networks in routing updates

Offset-list –To add an offset to incoming and outgoing metrics to routes learned via RIP

Passive-interface - To disable sending routing updates on an interface.

Redistribute - To redistribute routes from one routing domain into another routing domain.

Timers – adjust routing timers

Validate-update-source - Perform sanity checks against source address of routing updates

Show ip route – show all routes learned through RIP

Debug ip rip - To show RIP operation information and update messages sent or received by routers.

Note!

The difference between RIPV1 and RIPV2 is RIPV2 is not a new protocol; rather it is RIPV1 with some extensions. The most of important extensions in RIPV2 is addition of a Subnet mask field to the routing update entries, enabling the use of VLSM.

Example of RIP

```
ERT_805# show run
```

```
Building configuration ...
description fault
service password-encryption
service timestamps debug
!
hostname ERT_805
!
enable password 7 3EDRIxtqRWCA
!
username router password 7 65WeJR6evnrR3mP
crypto ipsec transform-set transform-1 esp-3des esp-md5-hmac
!
crypto map dynmap 1 ipsec-isakmp
  set transform-set transform-1
  set peer 10.0.0.2
  match address 100
!
crypto isakmp policy 1
  authentication pre-share
  group 1
  hash md5
!
crypto isakmp key 12345678 address 10.0.0.2 255.255.255.192
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  ip ospf network point-to-point
  crypto map dynmap
  clockrate 48000
!
interface async 0/0
!
router rip
  version 2
```

```
  network 10.0.0.0
  network 192.168.99.0
!
line vty 0 5
  login
  password 7 wAVcXxom8sGSOA
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 192.168.98.0 0.0.0.255
!
end

ERT_805#
ERT_805# show ip route
Codes: A--all O--ospf S--static R--rip C--connected E--egp T--tunnel
      o--cdp D--EIGRP    [Distance/Metric] g<Group#>

S    0.0.0.0/0 [2/0] via 10.0.0.2 serial0/0* act
C    10.0.0.0/26 [0/1] via 10.0.0.1 serial0/0* act
C    10.0.0.2/32 [1/0] via 10.0.0.1 serial0/0* act
R    192.168.98.0/24 [120/1] via 10.0.0.2 ttl=160, serial0/0* act
C    192.168.99.0/24 [0/1] via 192.168.99.64 fastethernet0/0* act
ERT_805#
```

4.2 EIGRP – Enhanced interior Gateway Routing Protocol

EIGRP is distance-vector protocol that combines the advantage of distance-vector and link state protocol. The different between these two protocols is distance-vector protocol shares everything it knows with directly connected neighbor only. Link state protocols announce information with directly connected links but share the information with all routers in same area. Because EIGRP is distance-vector therefore it's run of the Bellman Ford protocol. These protocols are prone to routing loops and counting to infinity. As result they must implement loop-avoidance such as split horizon, route poisoning and holddown timers.

4.2.1 EIRGP Command

router eigrp autonomous system number– enable eigrp in global configuration mode.

Network – enable routing on an IP network

Neighbor – Specify a neighbor router

Auto-summary – Enable automatic network number summarization

Bind-interface – enable EIGRP protocol on some interface

Distance – define an administrative distance

Distribute-list – filter networks in routing updates

Metric/e – modify EIREP routing metrics and parameters

Passive-interface - To disable sending routing updates on an interface.

Redistribute eigrp – redistribute information from other routing protocol and there are some optional value allow user to configure which is **bandwidth**, **delay**, **reliability**, **loading** and **mtu**.

Ip hello-interval eigrp autonomous system number– configure EIGRP hello interval

Ip hold-time eigrp autonomous system number – configure EIGRP hold time

Show ip eigrp interface [detail/AS number] – display interface information.

Following is the example:

```
ERT_805# show ip eigrp interface
IP-EIGRP neighbors for process 1
Interface    Peers   bandwidth   delay    state
fastethernet0/0       0        10000     1000     1
serial0/0       1        1544     20000     1
ERT_805#
```

Show ip eigrp neighbor [detail/AS number] – display information of neighbor

```
ERT_805# show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address     Interface   Hold    Uptime  Seq
                                    (sec)   (Num)
0   10.0.0.2    serial0/0   20      00:45:10   4

RT_805#

ERT_805# show run
Building configuration ...
description fault
service password-encryption
service timestamps debug
!
hostname ERT_805
!
enable password 7 3EDRIxtqRWCA
!
username router password 7 65WeJR6evnrR3mP
crypto ipsec transform-set transform-1 esp-3des esp-md5-hmac
!
crypto map dynmap 1 ipsec-isakmp
  set transform-set transform-1
  set peer 10.0.0.2
  match address 100
!
crypto isakmp policy 1
```

```
  authentication pre-share
  group 1
  hash md5
!
crypto isakmp key 12345678 address 10.0.0.2 255.255.255.192
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  crypto map dynmap
  ip hold-time eigrp 1 20
  clockrate 48000
!
interface async 0/0
!
router eigrp 1
  network 192.168.99.0
  network 10.0.0.0
!
line vty 0 5
  login
  password 7 wAVcXxom8sGSOA
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 192.168.98.0 0.0.0.255
!
end
```

ERT_805#

4.3 OSPF- Open Shortest Path First

OSPF is a link state protocol and it uses Dijkstra's Shortest Path First algorithm to run on the link state database. This technology is opposed to a distance-vector technology. OSPF router protocol is interior gateway router protocol that used to make decision on routes in Autonomous system. The link state protocol is use a cost metric to determine the best path to a destination.

When router or network's topology start to change the routing protocol will generate a LSA and flood it to notify the area or network that belongs.

Types of area

Standard area – This area can accept intra-area, inter-area and external router. This area also can be backbone area.

Backbone area – the backbone (transit) area always labeled area 0. Backbone area is a central entity that contains all other area. The backbone is responsible for distributing routing information between non-backbone areas

Stub area – this area do not accept router that belong to external autonomous system (AS). The routers in stub area use a default route to reach outside autonomous system.

Totally stubby area – This area that does not accept routes from other intra-area and default routes to be propagated within the area. If the router needs to send a packet to outside of area, it sends it using a default route.

Not-so-stubby-area – this area allows limited number of external routes that imports into area.

Types of routers

Internal router – routers that directly connected to the networks belong to the same area.

Backbone router – The router that connect with other Autonomous system bye physical or victual link.

Area border router (ABR) – A router that attached to multiple areas. ABR routers maintain the separate database for each area that connects with. Then ABR condense the topological information for their attached area and distribute to the backbone area.

Autonomous System Boundary router (ASBR) – This router have at least one interface connect to another autonomous system.

Types of OSPF Network Topologies

Point-to-point – Two routers that directly connect each other by serial interface.

Broadcast multiaccess – Network that connects more then two routers together with broadcast capability. Such as Ethernet is a broadcast multiaccess.

Nonbroadcast multiaccess (NBMA) – Network support many routers but having no broadcast capability.

4.3.1 OSPF Command

router ospf <ospf ID> - enable OSPF in global configuration mode.

Network area - address wildcard-mask **area** area-id

Neighbor [poll-interval | priority] - Specify a neighbor router. For point-to-Multipoint and NBMA networks, neighbor must be configured. **Poll-interval** is for ospf dead-router polling interval. **Priority** is for ospf priority of non-broadcast neighbor.

Area – OSPF area parameters

area area-id **authentification** -specifying the authentification type is single authentification

area area-id **authentification message-digest** -specifying the authentification type is Cryptographic authentication*/

area area-id **stub [no-summary]** - specifying the area is stub area*/ /* no-summary emphasizes the only default summary LSA produced into the area

area area-id **default-cost** cost- For stub area, default summary LSA cost's value

area area-id **nssa** -specifying the area is NSSA area

area area-id **range** address mask [**advertise** | **not-advertise**] **-** configuring the area parameter of range which used to condense the network topology information */

distance admin-distance

redistribute [connected | rip | static]

ip ospf network [broadcast | non-broadcast | point-to-point | point-to-Multipoint]

ip ospf cost cost - default value is 1

ip ospf retransmit-interval -seconds default value is 5 seconds

ip ospf transmit-delay seconds- default value is 1 seconds

ip ospf priority number- It is valid only for Broadcast and NBMA networks

ip ospf hello-interval -seconds

ip ospf dead-interval -seconds

ip ospf authentification-key key -key's max length is 8 Bytes, it is valid when area's authentification type is single authentification

ip ospf message-digest-key keyid **md5** key - key's max length is 16 Bytes, it is valid when area's authentification type is Cryptographic authentication

Configuration Example

```
Router Software Version 4220lab-RT805 on ERT805  (4.2c )

User Access Verification

Password:
ERT-805> enable
```

```
Password:
ERT_805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password level 15 7 aNTUS0QSfz8T
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation hdlc
  ip address 10.0.0.1 255.255.255.192
  ip ospf priority 255
  clockrate 48000
!
interface async 0/0
!
router ospf 2
  network 192.168.99.0 0.0.0.255 area 0
  network 10.0.0.0 0.0.0.255 area 0
!
line vty 0 4
  login
  password 7 hd3cpRj4s14LeA
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
!
end

ERT_805#
```

4.4 PPP

PPP (point-to-point) has provides a standard method for transport multi-protocol over ppp.

PPP is comprise of three main functional components, which is:

- PPP has a method for encapsulating multi-protocol datagrams
- Link Control Protocol (LCP) establishes, configures, authenticates and testing the data-link connection.
- Network Control Protocol (NCP) establish and configure different network-layer protocol.

PPP provides two authentications which is:

- Password Authentication protocol (PAP)
- Challenge Handshake Authentication protocol (CHAP)

PPP authentication using PAP

PAP is using two-way handshake to establish its identity. After PPP link establishment is complete, the authenticator repeatedly sends username and password until the authentication is acknowledged or the connection is terminated.

PAP is not an authentication protocol because password is sends cross the link by clear text and it’s not protection from playback.

PPP authentication using CHAP

CHAP is using three way handshakes to establish it identify. After the PPP link is establishment is complete, the server sends challenge to the remote node. The remote note responds with a value calculated by using a one-way hash function (typically MD5). The server checks the response against its own calculation of expected hash value. If the values match, the authentication is acknowledged. CHAP is more secured then PAP because it is supports protection against playback attack through the use of a variable challenge value that is unique and unpredictable. The use of repeated challenges is intended to limit the time of exposure to any single attack. The access server is in control of the frequency and timing of the challenges.

The following is showing a typical PPP session.

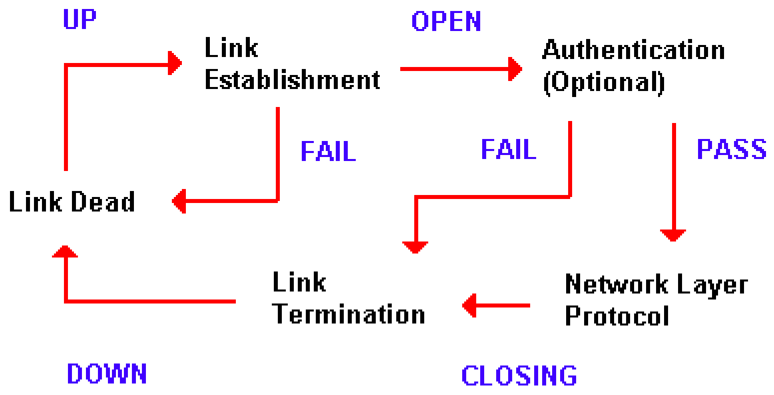


Figure 4-2 Networking diagram of PAP and CHAP authentication example

encapsulation ppp – encapsulation style to ppp style (interface command)

ppp authentication [pap | chap - enable the PAP or CHAP authentication

username username **password** password **[callback-dialstring]–** add the username and password of the peer into the local user. Callback-dialstring is for callback command in global command

ppp compress [predictor | stacker] – configure predictor or stacker compress on the interface

ip tcp header-compress – configure tcp header compress on the interface.

ppp callback [accept | initiate] – configure callback on interface accept is configured in server and initiate is configured in client

Configuration Example

CHAP example

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
```

```
hostname router
!
enable password level 15 7 aNTUS0QSfz8T
!
username ERT-805 password 7 SBFV4NgG60tV
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  ppp authentication chap
  clockrate 48000
!
interface async 0/0
!
line vty 0 4
  login
  password 7 hd3cpRj4s14LeA
!
ip route 192.168.98.0 255.255.255.0 10.0.0.2
!
end

router#
ERT-805# show run
Building configurati
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 5EVbxkwzBvfT
!
username router password 7 XNDVyI32Zyje
!
interface fastethernet 0/0
```

```
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  ppp authentication chap
!
interface async 0/0
!
line vty 0 4
  login
  password 7 o2EUq2a6AFiY4D
!
ip route 192.168.99.0 255.255.255.0 10.0.0.1
!
end
```

PAP example

```
outer# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password level 15 7 aNTUS0QSfz8T
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  ppp authentication pap
  ppp pap sent-username router password 7 wRHOiZagh-kM
  ppp compress predictor
  ip tcp hearder-compression
!
```

```
interface async 0/0
!
line vty 0 4
 login
 password 7 hd3cpRj4s14LeA
!
ip route 192.168.98.0 255.255.255.0 10.0.0.2
!
end

router#



ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
enable password 7 5EVbxkwzBvfT
!
username router password 7 qBjbURagjK0L
!
interface fastethernet 0/0
 ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
 encapsulation ppp
 ip address 10.0.0.2 255.255.255.192
 ppp authentication pap
 ip tcp header-compression
 clockrate 48000
!
interface async 0/0
!
line vty 0 4
 login
 password 7 o2EUq2a6AFiY4D
```

```
!
ip route 192.168.99.0 255.255.255.0 10.0.0.1
!
end

ERT-805#
```

4.5 HDLC Protocol

Only when the interface operates in the synchronous mode, can it be encapsulated with HDLC.

encapsulation hdlc – encapsulation with hdlc type

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password level 15 7 aNTUS0QSfz8T
!
username ERT-805 password 7 3hlZiJYY6pOn
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation hdlc
  ip address 10.0.0.1 255.255.255.192
!
interface async 0/0
!
line vty 0 4
  login
  password 7 hd3cpRj4s14LeA
!
ip route 192.168.98.0 255.255.255.0 10.0.0.2
!
```

```
end

router#


router# debug hdlc s0/0
router#
03:59.544 %serial0/0 Hdlc Port debug turn on
04:01.399 serial0/0 HDLC O(len=162):CDP  01 b4 cc 27 00 01 00 0a 72 6f
75 74 65
04:01.399  72 00 02 00 11 00 00 00 01 01 01 cc 00 04 0a 00 00...
04:03.094 serial0/0 HDLC I(len=22):lmi peer_seq=155,local's=159
04:03.753 %HDLC serial0/0 Keepalive
04:03.753 serial0/0 HDLC O(len=22):lmi local_seq=160,peer's=155
04:13.093 serial0/0 HDLC I(len=22):lmi peer_seq=156,local's=160
04:13.753 %HDLC serial0/0 Keepalive
04:13.753 serial0/0 HDLC O(len=22):lmi local_seq=161,peer's=156
04:23.093 serial0/0 HDLC I(len=22):lmi peer_seq=157,local's=161
04:23.753 %HDLC serial0/0 Keepalive
04:23.753 serial0/0 HDLC O(len=22):lmi local_seq=162,peer's=157
04:33.093 serial0/0 HDLC I(len=22):lmi peer_seq=158,local's=162
04:33.753 %HDLC serial0/0 Keepalive
04:33.753 serial0/0 HDLC O(len=22):lmi local_seq=163,peer's=158
04:43.093 serial0/0 HDLC I(len=22):lmi peer_seq=159,local's=163
04:43.753 %HDLC serial0/0 Keepalive
04:43.753 serial0/0 HDLC O(len=22):lmi local_seq=164,peer's=159
04:52.259 serial0/0 HDLC I(len=163):CDP  01 b4 4d 92 00 01 00 0b 45 52
54 2d 38
04:52.259  30 35 00 02 00 11 00 00 00 01 01 01 cc 00 04 0a 00...
04:53.093 serial0/0 HDLC I(len=22):lmi peer_seq=160,local's=164
04:53.753 %HDLC serial0/0 Keepalive
04:53.753 serial0/0 HDLC O(len=22):lmi local_seq=165,peer's=160
05:01.400 serial0/0 HDLC O(len=162):CDP  01 b4 cc 27 00 01 00 0a 72 6f
75 74 65
05:01.400  72 00 02 00 11 00 00 00 01 01 01 cc 00 04 0a 00 00...
05:03.093 serial0/0 HDLC I(len=22):lmi peer_seq=161,local's=165
05:03.753 %HDLC serial0/0 Keepalive
05:03.753 serial0/0 HDLC O(len=22):lmi local_seq=166,peer's=161^C
```

```
router# no
05:13.094 serial0/0 HDLC I(len=22):lmi peer_seq=162,local's=166de
05:13.753 %HDLC serial0/0 Keepalive
05:13.753 serial0/0 HDLC O(len=22):lmi local_seq=167,peer's=162
```

4.6 SNA

4.6.1 Introduction

Switch-to-Switch Protocol (SSP) is a protocol specified in the DLSw standard that routers use to establish DLSw connections, locate resources, forward data, and handle flow control and error recovery.

SSP provides encapsulation on TCP/IP and makes use of the reliable data transmission of TCP/IP between DLSw peers.

dlsw local-peer [biu-segment | bprder| cost | group | init-pacing-window | keepalive | lf | passive | peer-id | promisecuous] – Define dlsw local peer

dlsw remote-peer list **tcp** ip address **[backup | cost | dmac-output-list | dynamic | inactivity | keepalive | lf | linger | lsap-output-list | no-llc | passive | priority | tcp-queue-max | timeout]** – Define TCP encapsulation on DLSw Remote peer

dlsw bridge-group – link DLSw to the bridge group

dlsw timers [connect-timeout | explorer-delay-time | explorer-wait-time | icannotreach-block-time | local-connect-timeout | sna-cache-timeout | sna-explorer-timeout | sna-group-cache | sna-retry-interval | sna-verify-interval] – define the dlsw timers

Encapsulation sdlc – encapsulation type to sdlc

sdlc address – assign the secondary stations attached to primary station

sdlc holdq – set max number of packet hold in queue

sdlc k – set the local window size

sdlc n1 –set the max size of incoming frame

sdlc n2 - Set the number of times a Cisco IOS software will retry an operation that has timed out

sdlc ip-subnet – specify IP subnet

sdlc partner - Specify the destination address with which an LLC session is established for the SDLC station

sdlc role – establish role of the interface

sdlc-largest-frame- Set the largest I-frame size that can be sent or received by the designated SDLC station

sdlc simultaneous [full-datemode | half-datamode] - **full-datemode** is enable the primary station to send data to and receive data from the polled secondary station. **half-datamode** is Prohibit the primary stations from sending data to the polled secondary station.

sdlc t1 - Control the amount of time the Cisco IOS software waits for a reply

sdlc vmac – configure a MAC for the serial interface.

sdlc dlsw – enable DLSw on an SDLC interface

sdlc xid - Specify the XID value to be associated with the SDLC station

sdlc poll-limit-value – configure the number of times router can poll a secondary station time

sdlc poll-pause-timer – configure the time that router pause between sending each poll frame to secondary station

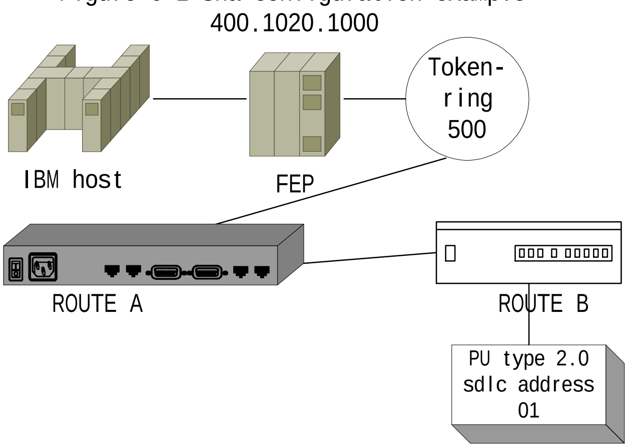
sdlc poll-wait-timeout - specify the interval the router will wait for polls from a primary node before timing out that connection.

sdlc rnr-limit – configure the time that router allows its adjacent linkstation to remain in a busy (RNR) state before declaring it inoperative

sdlc slow-poll – enable the slow-poll capability of the router as a primary SDLC station

sdlc t2 – configure the pool time

Figure 6-1 sna configuration example



Configuration for Router A:

```
hostname RouterA
!
source-bridge ring-group 2000
dlsw local-peer peer-id 150.150.10.2
dlsw remote-peer 0 TCP 150.150.10.1
!
interface serial 8
    IP address 150.150.10.2 255.255.255.192
    clockrate 56000
!
interface tokening 0
    no Ip address
    ring-speed 16
    source-bridge 500 1 2000
    source-bridge spanning
Configuration for Router B
hostname RouterB
!
dlsw local-peer peer-id 150.150.10.1
dlsw remote-peer 0 TCP 150.150.10.2
!
interface serial 1
    encapsulation hdlc
    Ip address 150.150.10.1 255.255.255.192
    no shutdown
!
interface serial 2
    encapsulation sdlc
    clock rate 9600
    sdlc role primary
    sdlc vmac 4000.9999.0100
    sdlc address 01
    sdlc xid 01 05d20066
    sdlc partner 4000.1020.1000 01
    sdlc dlsw 01
                      no shutdown
```

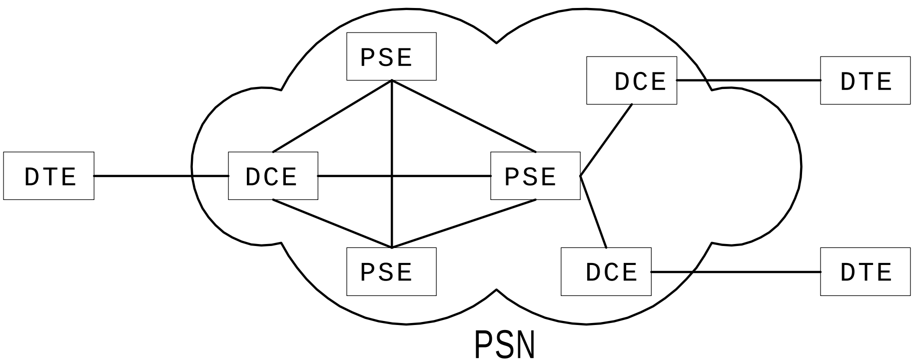
4.7 X.25 Protocol

The X.25 protocol is defines the connection between data terminal equipment (DTE) and circuit-terminating equipment (DCE). X.25 is the protocol of point-to-point interaction between DTE and DCE equipment.

DTE usually refers to the host or terminal at the user side and DCE usually refers to the synchronous modem. DTE is connected with DCE directly. DCE is connected to a port of packet switching exchange, and some connections are established between the packet switching exchanges, thus forming the paths between different DTE.

With X.25, two DTE is able to communication to each other. Once a DTE device contacts another to request a communication session then it means session communication is established. If the request is accepted, the two systems begin full-duplex information transfer. The following datagram is shown the relation between entities in X.25 network

图1-1 x.25网络模型



DTE 数据终端设备
DCE 数据电路终接设备
PSE 分组交换设备
PSN 分组交换网

The X.25 packet-switching protocol suits map to the lower three layers of the OSI (Open system Interconnection) model. X.25 layer 3 (packet-layer protocol) describes the format of packet used by the packet layer and the procedure of packet switching between two 3-layer entities. X.25 layer 2 (link-layer protocol), also called LAPB (Link Access Procedure Balanced), defines the format and procedure of interactive frames between DTE and DCE. X.25 layer 1 (physical-layer protocol) defines some physical and electrical characteristics in the connection between DTE and DCE. The above relation is shown in the following diagram.

VC (virtual Circuits) is logic connection between two network devices. VC is a logic and bi-directional path from one DTE device to another cross an X>25 network. There are two types of VC, which is permanent virtual circuit (PVC) and switch virtual circuit (SVC). The different between PVC and SVC is PVC is permanently established connections used for frequent and consistent data transfers and not use call setup and call clear.

encapsulation x25 [dce | dte] – set the encapsulation style to X.25 type

x25 address – enable the X.21 address

x25 map [Qllc] – Create the mapping from the destination protocol address to X.121 address

x25 check-called-address – check incoming calls address

x25 check-calling-address – check outbound call address

x25 compression [predictor | stacker] – enable packet compression for x25

x25 lic – set the low incoming circuit

x25 hic – set the low incoming circuit

x25 ltc – set the low two-way circuit

x25 htc – set the high two-way circuit

x25 loc – set the low outgoing circuit

x25 hoc – set the high outgoing circuit

x25 ips – set the default maximum incoming packet size, default 128bytes

x25 ops – set the default maximum outgoing packet size. Default 128bytes

x25 win – set the default receiving window size

x25 wout – set the default sending window size

x25 modulus – setting X.25 packet number modulo. Either 8 or 128

x25 t20 – set DTE restart request retransmission timer

x25 facility -

Operation	Command
Specify CUG (Closed User Group)	X.25 facility facility-number cug group-number
Input the user facility number in hexadecimal	X.25 facility *byte-string*
Perform flow control parameter negotiation while initiating a call	X.25 facility facility-number packetsize in-size out-size

	X.25 facility facility-number window size in-size out-size
Request reverse charging while initiating a call	X.25 facility facility-number reverse
Request throughput-level negotiation while initiating a call	X.25 facility facility-number throughput in out
Network user ID	X.25 facility facility-number throughput in out

x25 t21 – set DTE call request retransmission timer

x25 t22 – set DTE reset request retransmission timer

x25 t23- set DTE clear request retransmission timer

x25 r20 – set the maximum number of the timeout (restart)

x25 r22 – set the maximum number of the timeout (restore)

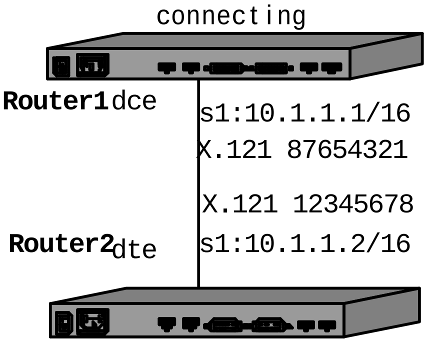
x25 r23- set the Maximum number of the timeout (clear)

x25 pvc – create a permanent virtual circuit

x25 idle – specify the maximum idle time on interface

Two routers connected with cable

Figure 1-14 Two routers connecting



router configuration：(Use DCE cable)

Router1：

interface serial 1
encapsulation x25 dce
ip address 10.1.1.1 255.255.0.0

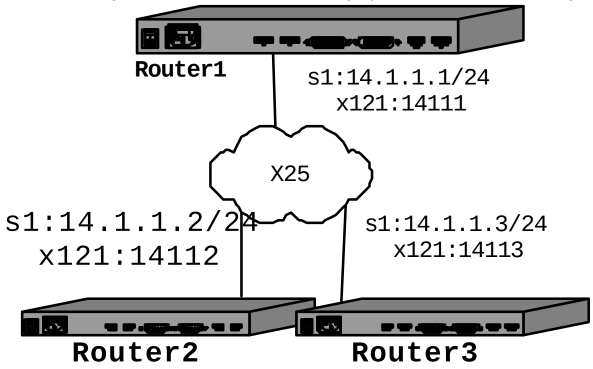
x25 address 87654321
x25 map ip 10.1.1.2 12345678
clockrate 9600

Router2：

interface serial 1
encapsulation x25 dte
ip address 10.1.1.2 255.255.0.0
x25 address 12345678
x25 map ip 10.1.1.1 87654321

Access packet switching network

Figure 1-16 Accessing packet switching network



Router1：

interface serial 1
encapsulation x25
ip address 14.1.1.1 255.255.255.0
x25 address 14111
x25 map ip 14.1.1.2 14112
x25 map ip 14.1.1.3 14113

Router2：

interface serial 1
encapsulation x25
ip address 14.1.1.2 255.255.255.0
x25 address 14112
x25 map ip 14.1.1.1 14111
x25 map ip 14.1.1.3 14113

Router3：

interface serial 1
encapsulation x25
ip address 14.1.1.3 255.255.255.0
x25 address 14113
x25 map ip 14.1.1.1 14111

```
  x25 map ip 14.1.1.2 14112
```

Set up network with PVC

Router1：

```
interface serial 1
  encapsulation x25
  ip address 14.1.1.1 255.255.255.0
  x25 address 14111
  x25 ltc 3
  x25 pvc 1 ip 14.1.1.2
  x25 pvc 2 ip 14.1.1.3
```

Router2：

```
interface serial 1
  encapsulation x25
  ip address 14.1.1.2 255.255.255.0
  x25 address 14112
  x25 ltc 3
  x25 pvc 1 ip 14.1.1.1
  x25 pvc 2 ip 14.1.1.3
```

Router3：

```
interface serial 1
  encapsulation x25
  ip address 14.1.1.3 255.255.255.0
  x25 address 14113
  x25 ltc 3
  x25 pvc 1 ip 14.1.1.1
  x25 pvc 2 ip 14.1.1.2
```

4.8 Frame Relay Protocol

Frame relay protocol is provides multiplexing logical data conversations over a single physical transmission link by assigning connection identify to each DTE devices.

Frame relay also supports PVC and SVC for data transfer between DTE devices. The different between X.25 and frame relay is frame relay doesn’t have the windowing and retransmission strategies. Also frame relay is only layer 2 protocol.

DLCI (data-link connection identifier) identifies the logical virtual circuit between DTE and frame relay switch.

Frame Relay signaling

LMI (local management interface) is responsible for managing the connection and maintaining status between the CPE devices and the FR switch.

The frame relay switch, which is responds one or more LMI types. There are three different LMI types: cisco, ansi and q933a.

encapsulation frame-relay – encapsulation frame relay type on serial interface

frame-relay map ip protocol address **dlci [broadcast | gateway-down | interface-down | payload-compression]** – configure static address mapping

frame-relay dlic-group – assign DLCI to some group

frame-relay fist-dlic – the number of first dlci (16-1007)

frame-relay intf-type – configure frame-relay interface type (dec, dte)

frame-relay inverse-arp – Enable/Disable inverse ARP

frame-relay lapf – set lapf parameter

frame-relay lmi-n391 – set the counter on PVC status enquiry message

frame-relay lmi-n392 – set the LMI error threshold

frame-relay lmi-n393 – set LMI monitor event counter

frame-relay lmi-t391 – set LMI T391 timer (0-4294967295)

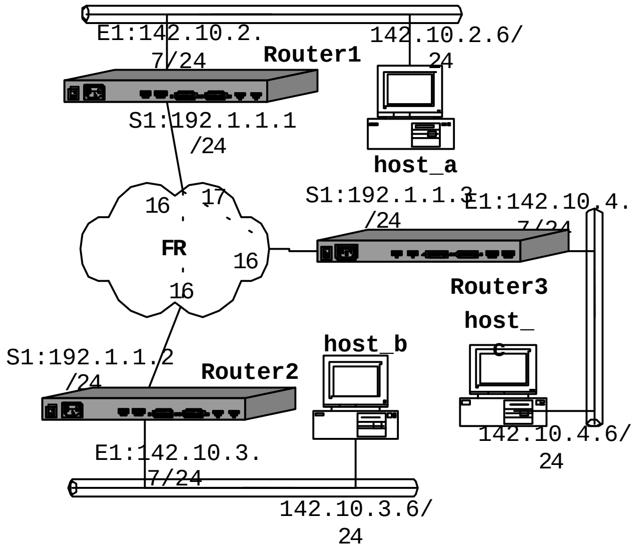
frame-relay lmi-t392 – set DCE request confirm timer (3-30)

frame-relay lmi-type – set LMI type (ansi, cisco, q933a)

frame-relay local-dlci – set local dlci

frame-relay num-dlci – Assign the frame relay DLCI number

Figure 2-1 Configuration Example



(1) Router1 Configuration:

```
Router1>enable
Router1#conf term
Router1 (config)#interface s1
Router1 (config-if)#enca fram
Router1 (config-if)#no sh
Router1 (config-if)#Ip addr 192.1.1.1 255.255.255.0
Router1 (config-if)#fram first-dlci 16
Router1 (config-if)#fram map IP 192.1.1.2 16
Router1 (config-if)#fram map IP 192.1.1.3 17
Router1 (config-if)# exit
Router1 (config)#int e1
Router1 (config-if)# no shut
Router1 (config-if)# Ip addr 142.10.2.7 255.255.255.0
Router1 (config-if)# exit
Router1 (config)#IP route 142.10.3.0 255.255.255.0 192.1.1.2
Router1 (config)#IP route 142.10.4.0 255.255.255.0 192.1.1.3
Router1 (config)#exit
Router1#wr
```

(2) Router2 configuration:

```
Router2>enable
```

```
Router2#conf term
Router2 (config)#interface s1
Router2 (config-if)#enca fram
Router2 (config-if)#no sh
Router2 (config-if)#Ip addr 192.1.1.2 255.255.255.0
Router2 (config-if)#fram first-dlci 16
Router2 (config-if)#fram map IP 192.1.1.1 16
Router2 (config-if)#exit
Router2 (config)#int e1
Router2 (config-if)#no shut
Router2 (config-if)#Ip addr 142.10.3.7 255.255.255.0
Router2 (config-if)#exit
Router2 (config)#IP route 142.10.2.0 255.255.255.0 192.1.1.1
Router2 (config)#exit
Router2#wr
```

(2) Router3 configuration:

```
Router3>enable
Router3#conf term
Router3 (config)#interface s1
Router3 (config-if)#enca fram
Router3 (config-if)#no sh
Router3 (config-if)#Ip addr 192.1.1.3 255.255.255.0
Router3 (config-if)#fram first-dlci 16
Router3 (config-if)#fram map IP 192.1.1.1 16
Router3 (config-if)#exit
Router3 (config)#int e1
Router3 (config-if)#no shut
Router3 (config-if)#Ip addr 142.10.4.7 255.255.255.0
Router3 (config-if)#exit
Router3 (config)#IP route 142.10.2.0 255.255.255.0 192.1.1.1
Router3 (config)#exit
Router3#wr
```

Chapter 5 Security

5.1 Access-list

The purpose for access-list is packet filtering to control, which packets move through the network. Such control can help limit network traffic and restrict network use by certain user or device.
Access-list is use as a packet filter, this function helps to limit network traffic and restrict network.

There are two general types of access lists:

- **Standard access-lists** – The standard access-list is check the source address of packets. Access-list number is start from 1-99

- **Extended access-list** – The extended access-list is check for both source and destination packet address and also check for specific protocols, port numbers and other parameters. Access-list number is start from 100-199

access-list access-list number **[permit | deny]** – set the standard access-list's rule.

ip access-group [in | out] – applies an existing access-list as an incoming or outgoing to an interface.

Access-list access-list number **[permit | deny]** protocol source-address source-wildcard destination-address destination-wildcard [operator port] – set the extended access-list rule.

Standard access-list configuration example

```
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 5EVbxkwzBvfT
!
username router password 7 qBjbURagjK0L
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
```

```
  ip address 10.0.0.2 255.255.255.192
  ip access-group 1 out
   clockrate 48000
!
interface async 0/0
!
router rip
  network 192.168.98.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 o2EUq2a6AFiY4D
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1
!
access-list 1 permit host 192.168.98.62
access-list 1 permit host 192.168.98.63
access-list 1 permit host 192.168.98.64
access-list 1 permit host 10.0.0.0
access-list 1 deny any
!
end

ERT-805#
```

Extended access-list configuration example

```
ERT-805#

ERT-805# show run

Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
```

```
enable password 7 5EVbxkwzBvfT
!
username router password 7 qBjbURagjK0L
!
interface fastethernet 0/0
 ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
 encapsulation ppp
 ip address 10.0.0.2 255.255.255.192
 ip access-group 100 out
 clockrate 48000
!
interface async 0/0
!
router rip
 network 192.168.98.0
 network 10.0.0.0
!
line vty 0 4
 login
 password 7 o2EUq2a6AFiY4D
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1
!
access-list 100 deny tcp 192.168.98.66 0.0.0.0 host 192.168.99.61 eq 21
access-list 100 permit ip any any
!
end

ERT-805#
```

5.2 NAT – Network Address Translation

IP address depletion is a main problem that facing in the public network. NAT (network address translation) is a solution that allows the IP network of an organization to appear from the outside to use different IP address then it own IP address.

Because the IP address is depletion therefore not all your hosts have global unique IP addresses. NAT technology is translates the private IP address into public IP address before sending packets to the outside network. There are two different methods, which is static and dynamic NAT.

ip nat inside source static local-ip golobal-ip – configure static NAT

ip nat [inside | outside] – Enable NAT on at least one and one outside interface by interface command

ip nat pool pool name srat-ip end-ip **netmask [prefix-length | type rotary]** - Define a pool of global addresses to be allocated as needed.

Ip nat inside source list access-list no **pool** pool name [**overload]**- Establish dynamic source translation, specifying the access list defined in the prior step. [option] **overload**, add the overload key word to the command

Access-list access-list number **permit** source address [source wildcard bits]

Ip nat inside destination list access-list number **pool** pool name – Establish dynamic inside destination translation,

Ip nat outside source list access-list no **pool** pool name **-** Establish dynamic outside source translation, specifying the access list defined in the prior step

Show ip nat translation – display the active translations

Show ip nat statistics – display

Debug ip nat [detailed] – display a line of output for each packet that gets translated.

Clear ip nat translation * - to clear all translated entries.

Clear ip nat translation inside gip lip [**outside** <gip> <lip>] – clear both of inside or outside translation

Clear ip nat translation outside lip gip – clear outside translation

Static NAT Configuration

```
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 5EVbxkwzBvfT
!
username router password 7 qBjbURagjK0L
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
  ip nat inside
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  ip nat outside
  clockrate 48000
!
interface async 0/0
!
router rip
  network 192.168.98.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 o2EUq2a6AFiY4D
!
ip nat inside source static 192.168.98.62 10.0.1.1
!
access-list 1 permit 192.168.98.62 0.0.0.255
access-list 1 permit 10.0.0.2 0.0.0.255
!
end
```

```
ERT-805#
```

2	0.100360	65369.1	0.255	ZIP	GetNetInfo request
3	0.200114	65369.1	0.255	ZIP	GetNetInfo request
4	0.300466	65369.1	0.255	ZIP	GetNetInfo request
5	0.461972	65369.1	0.255	ZIP	GetNetInfo request
6	0.698621	Cellvisi_00:ed:de	Broadcast	ARP	Who has 192.168.0.20? T
7	0.724407	192.168.0.20	255.255.255.255	UDP	Source port: 62976 Dest
8	0.827507	10.0.1.1	192.168.99.61	TCP	1529 > ftp [SYN] Seq=165
9	0.827582	192.168.99.61	10.0.1.1	TCP	ftp > 1529 [SYN, ACK] Se
10	0.851406	10.0.1.1	192.168.99.61	TCP	1529 > ftp [ACK] Seq=165
11	0.851563	192.168.99.61	10.0.1.1	FTP	Response: 220 planet-52a
12	1.027385	10.0.1.1	192.168.99.61	TCP	1529 > ftp [ACK] Seq=165
13	3.575164	65369.2	0.255	ZIP	GetNetInfo request
14	3.675152	65369.2	0.255	ZIP	GetNetInfo request
15	3.775567	65369.2	0.255	ZIP	GetNetInfo request
16	3.875570	65369.2	0.255	ZIP	GetNetInfo request

Figure of static NAT example result

```
ERT-805# show ip nat translations
Total 1 NAT translations
Pro Inside Local    Inside Global   Outside Global  TTL
---                 192.168.98.62:0 10.0.1.1:0
ERT-805#
```

Dynamic NAT Configuration

```
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 5EVbxkwzBvfT
username router password 7 qBjbURagjK0L
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
  ip nat inside
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
```

```
  ip address 10.0.1.1 255.255.255.192 secondary
  ip nat outside
  ip access-group 1 out
  clockrate 48000
!
interface async 0/0
!
router rip
  network 192.168.98.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 o2EUq2a6AFiY4D
!
ip nat pool overload 10.0.1.1 10.0.1.1 netmask 255.255.255.192
ip nat inside source list 1 pool overload overload
!
access-list 1 permit 192.168.98.62 0.0.0.255
access-list 1 permit 10.0.0.2 0.0.0.255 !
end
```

5.3 VPN - IPSec

IPSec is an implement secures the VPN (Virtual private Network). IPSec protocol includes AH (Authentication Header), ESP (Encapsulation Security Payload) and IKE (Internet Key Exchange), ISAKMP and transform.

Ipsec security architecture provides data confidentiality, data integrality, identity authentication, anti-replay and DOS services. Security mechanism is implemented by AH(Authentication Header) protocol and ESP(Encapsulation Security Payload) protocol. Key management is implemented by IKE. The peers use SPI(Security Policy Index) to quote the dynamic negotiated SA(Security Association) to provide data security.

crypto ipsec transform-set transform-name **[**transform 1**] [**transform 2**] [**transform 3**]**– to define the transform set that combination of security protocols and algorithms.

mode [tunnel **|** transport**]** – specify the mode for transform set. The default mode is tunnel.

Initialization-vector size [4 | 8**]** – to modify the length of the initialization-vector. The default is 8

crypto ipsec security-association lifetime [kilobytes | seconds**] –** to modify the time value when negotiating Ipsec security.

crypto map map-name map number **[ipsec-isakmp | ipsec-manual]** – create a crypto map entry. Ipsec-isakmp is used to establish the Ipsec security for protecting the traffic. Ipsec-maunal is not using IKE to establish the ipsec secutiry.

crypto map map name map number **ipsec-manual**

- **Match address** – specify the extended access list for crypto map
- **Transform-set** - specify the transform sets that used with the crypto map entry
- **set peer [**hostname | ip address**]** – specify the IPsec peer in a crypto map
- **set session key [inbound | outbound] [ah| esp]** spi **[ciper]** hex-key-data **[authenticator]** hex-key-data
  - **inbound** – set inbound session key
  - **outbound-** set outbound session key
  - **ah –** set AH protocol for Ipsec session key
  - **ciper** - Indicates that the key is to be used with the ESP encryption .
  - **authenticator** – (optional) Indicates that the key is to be used with the ESP encryption

crypto map map name map number **ipsec-isakmp**

- **match address** – specify the extended access list for crypto map
- **set peer [**hostname | ip address**]** – specify the IPsec peer in a crypto map
- **set Transform-set** - specify the transform sets that used with the crypto map entry
- **set pfs [group 1 | group 2]** – specify the pfs setting. Group 1 is 769-bit and group 2 is 1024 bit
- **set security-association [level | lifetime]**
  - **level per-host** - specify the IPSec security associations should be requested for each source/destination host pair
  - **lifetime [seconds | kilobytes]** - override the global lifetime value that is used when negotiating IPSec security.

crypto map dynamic-map dynamic-map name dynamic-seq no – Create dynamic-map entry.

crypto isakmp enable – enable Internet Key Exchange (IKE) at your router.

crypto isakmp key keystring **address** peer-address – configure preshared authentication key

crypto isakmp policy priority – to define Internet Key exchange (IKE) policy

- **hash**
- **encryption**
- **group**
- **authentication**
- **lifetime**

show crypto ipsec sa – shows current connections and information regarding encrypted and decrypted packets.

show crypto isakmp sa – view all current IKE security association at a peer.

clear crypto isakmp sa – clears the phase 1

clear crypto ipsec sa – clears the phase 2

debug crypto isakmp - Displays the ISAKMP negotiations of Phase 1.

Router 1

```
ERT_805# show run
Building configuration ...
description fault
service password-encryption
service timestamps debug
!
hostname ERT_805
!
enable password 7 3EDRIxtqRWCA
!
username router password 7 65WeJR6evnrR3mP
crypto ipsec transform-set transform-1 esp-3des esp-md5-hmac
!
crypto map dynmap 1 ipsec-isakmp
  set transform-set transform-1
  set peer 10.0.0.2
```

```
  match address 100
!
crypto isakmp policy 1
  authentication pre-share
  group 1
  hash md5
!
crypto isakmp key 12345678 address 10.0.0.2 255.255.255.192
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  crypto map dynmap
  clockrate 48000
!
interface async 0/0
!
line vty 0 5
  login
  password 7 wAVcXxom8sGSOA
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 192.168.98.0 0.0.0.255
!
end

ERT_805#
```

Router 2

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
```

```
!
hostname router
!
enable password 7 7JDUhlA4A907
!
username scott password 7 phTLTNmZFcwY3D
crypto ipsec transform-set transform-1 esp-3des esp-md5-hmac
!
crypto map dynmap 1 ipsec-isakmp
  set transform-set transfrom-1
  set peer 10.0.0.1
  match address 100
!
crypto isakmp policy 1
  authentication pre-share
  group 1
  hash md5
!
crypto isakmp key 12345678 address 10.0.0.1 255.255.255.192
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  crypto map dynmap
!
interface async 0/0
!
line vty 0 4
  login local
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1
!
access-list 100 permit ip 192.168.98.0 0.0.0.255 192.168.99.0 0.0.0.255
!
end
```

```
router#


router# debug crypto isakmp
router#
22:34.011 Crypto ISAKMP debugging is on
router# term
router# terminal m
router# terminal monitor
router# 23:03.993 IPSEC: SEND KEEYALIVE ON PEER 10.0.0.2

23:03.993 recv msg type=331, msg=08 0a 00 00 01 0a 00 00 02
23:03.993 recv Ipsec Msg
23:03.994 recv DPD req
23:03.994 creat a DPD struct
23:03.994 send R_U_THERE=00 00 00 20 00 00 00 01 01 10 8d 28 38 8b 12 ad e8 16
23:03.994 7f f7 5c 1c 4b 9b 2e 25 69 1a 01 27 c6 38
23:03.996 send msg=38 8b 12 ad e8 16 7f f7 5c 1c 4b 9b 2e 25 69 1a 08 10 05 01
23:03.996 b4 52 6e 59 00 00 00 54 8d da 57 8a 07 85 b6 49 62 10 70 a6 a8 df f4
23:03.996 ed d1 b7 fd e1 99 8a 60 d8 68 d8 e6 66 e8 f8 90 91 4c db 16 e6 e8 a5
23:03.996 f4 42 26 12 c5 c5 d7 85 ec 5c 7d 60 a1 4a 98 63 57 64
23:03.997 start IKE DPD timer conn= 17
23:03.049 recv msg type=100, msg=29 01 f4 01 f4 0a 00 00 02 0a 00 00 01 38 8b
1
23:03.049 2 ad e8 16 7f f7 5c 1c 4b 9b 2e 25 69 1a 08 10 05 01 b3 e7 a6 94 00
0
23:03.049 0 00 54 ef d8 1c 37 63 4f e6 27 f2 63 bd 03 93 b0 db 66 4a c2 d5 d6
e
23:03.049 c 01 74 ba d5 a1 88 1f 9e 6c 8a 40 5c f9 03 17 52 cd 98 c4 59 2f eb
1
23:03.049 6 70 1b 20 0e 0d ed 30 44 95 0d 17 39
23:03.050 recv ISAKMP:38 8b 12 ad e8 16 7f f7 5c 1c 4b 9b 2e 25 69 1a 08 10 05
23:03.050 01 b3 e7 a6 94 00 00 00 54 ef d8 1c 37 63 4f e6 27 f2 63 bd 03 93 b0
23:03.050 db 66 4a c2 d5 d6 ec 01 74 ba d5 a1 88 1f 9e 6c 8a 40 5c f9 03 17 52
23:03.050 cd 98 c4 59 2f eb 16 70 1b 20 0e 0d ed 30 44 95 0d 17 39, len=84
```

```
router# show crypto ipsec sa
interface: serial0/0
    Crypto map tag:dynmap, local addr:10.0.0.1
    Local ident (addr/mask/prot/port):192.168.99.0/255.255.255.0/0/0
    Remotel ident (addr/mask/prot/port):192.168.98.0/255.255.255.0/0/0
    PERMIT,flags={origin_is_acl,}
    Current Peer:10.0.0.2

    #pkts encaps:1160 ,pkts encrypts:1160, pkts digest:1160
    #pkts decaps:1160 ,pkts decrypts:1160, pkts verify:1160
    #pkts send errrors:0 ,pkts receive errors:0

     local crypto endpt.:10.0.0.1, remote crypto endpt.:10.0.0.2

     inbound esp sas:
      Spi: 0X103(259)  sastate_mature! p_sa=259
        transform: esp-md5-hmac, esp-3des
        In use setting:{Tunnel}
        crypto map: dynmap
        sa timing: remaining key lifetime (k/sec): (313021/3345)
        IV size: 8 bytes
        replay detection support: Y

     inbound pcp sas:

     outbound esp sas:
      Spi: 0X103(259)  sastate_mature!  p_sa=259  in use!
        transform: esp-md5-hmac, esp-3des
        In use setting:{Tunnel}
        crypto map: dynmap
        sa timing: remaining key lifetime (k/sec): (313026/3345)
        IV size: 8 bytes
        replay detection support: Y

     outbound pcp sas:

router#
```

Configure Ipsec Manual between routers

Router 2 **Router 1**

eth:192.168.98.63 s0/0 10.0.0.2 s0/0 10.0.0.1 eth:192.168.99.64

Router 1 configuration

```
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password level 15 7 EJketQjD8uBh
!
crypto ipsec transform-set test esp-des
!
crypto map dynmap 1 ipsec-manual
  set transform-set test
  set peer 10.0.0.1
  set session-key inbound esp 256 cipher 1234567890ABCDEF
  set session-key outbound esp 256 cipher 0123456789ABCDEF
  match address 100
!
no crypto isakmp enable
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  crypto map dynmap
  clockrate 48000
!
interface async 0/0
```

```
!
router rip
  network 192.168.98.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 iFEdTlElgPbW4D
!
!
access-list 100 permit ip 192.168.98.0 0.0.0.255 192.168.99.0 0.0.0.255
!
end
```

Router 2 configuration

```
ERT-805#
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password level 15 7 aNTUS0QSfz8T
!
crypto ipsec transform-set test esp-des
!
crypto map dynmap 1 ipsec-manual
  set transform-set test
  set peer 10.0.0.2
  set session-key inbound esp 256 cipher 0123456789ABCDEF
  set session-key outbound esp 256 cipher 1234567890ABCDEF
  match address 100
!
no crypto isakmp enable
!
interface fastethernet 0/0
```

```
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  crypto map dynmap
!
interface async 0/0
!
router rip
  network 192.168.99.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 hd3cpRj4s14LeA
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 192.168.98.0 0.0.0.255
!
end

router#
```

Dynamic example

Router 1- central router

```
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 St3Yuxw1NBTq
!
crypto ipsec transform-set scott esp-des ah-md5-hmac
!
crypto dynamic-map dy 1
  set transform-set scott
```

```
  match address 100
!
crypto map mm 1 ipsec-isakmp dynamic dy
crypto isakmp policy 1
  authentication pre-share
  hash md5
!
crypto isakmp key 1234 address 10.0.0.2 255.255.255.192
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  crypto map mm
  clockrate 48000
!
interface async 0/0
!
router rip
  network 192.168.99.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 kdWL6UXPkdPV/B
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 192.168.98.0 0.0.0.255
!
end

router#
```

Router 2 – remote side

```
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 uh4a5s35v9i6
!
crypto ipsec transform-set scott esp-des ah-md5-hmac
!
crypto map mm 1 ipsec-isakmp
 set transform-set scott
 set peer 10.0.0.1
 match address 100
!
crypto isakmp policy 1
 authentication pre-share
 hash md5
!
crypto isakmp key 1234 address 10.0.0.1 255.255.255.192
!
interface fastethernet 0/0
 ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
 encapsulation ppp
 ip address 10.0.0.2 255.255.255.192
 crypto map mm
!
interface async 0/0
!
router rip
 network 10.0.0.0
 network 192.168.98.0
!
line vty 0 4
 login
 password 7 3Z4SNtmYpBT6BC
```

```
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
!
access-list 100 permit ip 192.168.98.0 0.0.0.255 192.168.99.0 0.0.0.255
!
end

ERT-805#
```

router# **show crypto ipsec sa**

```
interface: serial0/0
   Crypto map tag:dynmap, local addr:10.0.0.1
   Local ident (addr/mask/prot/port):192.168.99.0/255.255.255.0/0/0
   Remotel ident (addr/mask/prot/port):192.168.98.0/255.255.255.0/0/0
   PERMIT,flags={origin_is_acl,}
   Current Peer:10.0.0.2

   #pkts encaps:1160 ,pkts encrypts:1160, pkts digest:1160
   #pkts decaps:1160 ,pkts decrypts:1160, pkts verify:1160
   #pkts send errrors:0 ,pkts receive errors:0

    local crypto endpt.:10.0.0.1, remote crypto endpt.:10.0.0.2

    inbound esp sas:
     Spi: 0X103(256)  sastate_mature! p_sa=256
      transform: esp-des
      In use setting:{Tunnel}
      crypto map: dynmap
      no sa timing:
      IV size: 8 bytes
      replay detection support: Y

    inbound pcp sas:

    outbound esp sas:
     Spi: 0X103(256)  sastate_mature!  p_sa=256  in use!
      transform: esp-des
      In use setting:{Tunnel}
```

```
        crypto map: dynmap
        no sa timing:
        IV size: 8 bytes
        replay detection support: Y

     outbound pcp sas:

router#
```

GRE Example

Router 1

```
ERT-805> enable
Password:
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 at1a2V/tbD6b
!
crypto ipsec transform-set marc esp-3des ah-md5-hmac
  initialization-vector size 8
!
crypto dynamic-map dy 1
  set transform-set marc
  match address 100
!
crypto map mm 1 ipsec-isakmp dynamic dy
crypto isakmp policy 1
  authentication pre-share
  hash sha
!
crypto isakmp key 1234 address 0.0.0.0 0.0.0.0
```

```
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation hdlc
  ip address 130.0.1.2 255.255.0.0 tunnel 10.0.0.1 10.0.0.2
  ip address 10.0.0.1 255.0.0.0 secondary
  crypto map mm
  clockrate 128000
!
interface async 0/0
!
router rip
  version 1
  network 192.168.99.0
  network 10.0.0.0
!
line vty 0 31
!
access-list 100 permit ip 192.168.99.0 0.0.0.255 10.0.0.0 0.0.0.255
!
end

ERT-805#
```

Router 2

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 wonRBhc01DcE
!
crypto ipsec transform-set marc esp-3des ah-md5-hmac
  initialization-vector size 8
```

```
!
crypto map mm 1 ipsec-isakmp
  set transform-set marc
  set peer 10.0.0.1
  match address 100
!
crypto isakmp policy 1
  authentication pre-share
  hash sha
!
crypto isakmp key 1234 address 10.0.0.1 255.0.0.0
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
  ip nat inside
!
interface serial 0/0
  encapsulation hdlc
  ip address 130.0.1.1 255.255.0.0 tunnel 10.0.0.2 10.0.0.1
  ip address 10.0.0.2 255.0.0.0 secondary
  ip address 10.0.0.3 255.0.0.0 secondary
  ip nat outside
  crypto map mm
!
interface async 0/0
!
router rip
  network 10.0.0.0
  network 192.168.98.0
!
line vty 0 4
  login
  password 7 k2CZPVdrqEggyC
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
ip nat pool overload 10.0.0.3 10.0.0.3 netmask 255.0.0.0
ip nat inside source list 1 pool overload overload
!
```

```
access-list 1 permit 192.168.98.62 0.0.0.255
access-list 100 permit ip 10.0.0.0 0.0.0.255 192.168.99.61 0.0.0.255
!
end

router#
ERT-805# show ip route
Codes: A--all O--ospf S--static R--rip C--connected E--egp T--tunnel
      o--cdp D--EIGRP, EX--EIGRP external, O--OSPF, IA--OSPF inter area
      N1--OSPF NSSA external type 1, N2--OSPF NSSA external type 2
      E1--OSPF external type 1, E2--OSPF external type 2
      [Distance/Metric] g<Group#>

C    10.0.0.0/8 [0/1] via 10.0.0.1 serial0/0* act
C    130.0.0.0/16 [0/1] via 130.0.1.2 Tunnel<serial0/0>* act
     192.168.98.0/24 [120/1]
R        via 10.0.0.3, ttl=150, serial0/0 act
R        via 10.0.0.2, ttl=150, serial0/0 act
C    192.168.99.0/24 [0/1] via 192.168.99.64 fastethernet0/0* act
ERT-805#
```

5.4 Firewall- Context-Based Access Control (CBAC)

Security is an important issue in IT world. Most of people may know about firewall, it is use to prevent unauthorized, external individuals from gaining access into your network. Context-Based Access Control (CBAC) is a new feature technology that turns your router into an effective and robust firewall.

CBAC is includes the following features:

- Basic and advanced traffic filtering
- Security serer support
- Network Address translation
- Cisco encryption technology
- IPSec network security

- Neighbor router authentication
- Even logging

CBAC uses timeout and thresholds to determine how long to manage information for a session and when to drop the session that connects is failed. CBAC is only check with TCP and UDP but not ICMP. The following example is showing the user how to configure CBAC.

ip inspect alert-off – disable alert

ip audit-trail – enable the logging of session information

ip dns-timeout – specify timeout for DNS

ip hashtable-size – specify size of hashtable

ip max-incomplete [low | high] – specify the number of incomplete connection before clamping

ip one-minute [low | high] – specify the rate of new unestablished TCP session that will cause the software to stop/start deleting half-open session

ip inspect udp idle-time – specify the idle timeout for udp

ip inspect tcp [finwait-time | idle-time | max-incomplete | synwait-time] – configure timeout value for tcp connections

- **finwait-time** – specify timeout for TCP connections after firewall detect a FIN exchange
- **idle-time** – specify the TCP connection idle-timeout
- **max-incomplete host** half-open session **block-time**- specify max half-open connection per host
- **synwait-time** – specify the timeout for TCP connects after SYN

ip inspect name name of inspect **[protocol] timeout** – configure CBAC inspection protocol eg tcp, http, udp, smtp and more.

show ip inspect all – show all CBAC configuration and all existing session

show ip inspect config – show the complete CBAC inspection configuration

show ip inspect name inspect name –show a particular inspection rule

show ip inspect interface – show interface configuration with inspection rule and access-list

show ip inspect session – display the current session that have been established

debug ip inspect events – display the information about CBAC events

debug ip inspect object-creation – display the message about object that create by CBAC.

debug ip inspect object-deletion – display the message about object being delete by CBAC

debug ip inspect protocol – display the information about protocol eg http, tcp, ftp…etc

Configuration Example

```
Building configuration...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 Pl2cGlY8liD4
!
interface fastethernet 0/0
 ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
 encapsulation ppp
 ip address 10.0.0.2 255.255.255.192
 ip access-group 100 in
 ip inspect test out
!
interface async 0/0
!
router rip
 network 10.0.0.0
 network 192.168.98.0
!
line vty 0 5
login
 password 7 tF4VZx7eRx5VcC
!
```

```
ip route 0.0.0.0 0.0.0.0 10.0.0.1
ip inspect audit-trail
ip inspect max-incomplete low 100
ip inspect max-incomplete high 120
ip inspect one-minute low 100
ip inspect one-minute high 120
ip inspect tcp synwait-time 50
ip inspect name test http
ip inspect name test ftp
ip inspect name test udp
ip inspect name test tcp
ip inspect name test smtp
ip inspect name test fragment maximum 100
!
access-list 100 permit tcp host 192.168.99.61 host 192.168.98.62
access-list 100 deny tcp any any
access-list 100 deny udp any any
access-list 100 permit ip any any
!
end
router#
router# show ip inspect sessions
 CBAC built 2 sessions:
 dns: 192.168.98.62(1034)=>168.95.1.1(53) state:UDP_CLIENT_SYN (0X40227)
 dns: 192.168.98.62(1034)=>139.175.55.244(53) state:UDP_CLIENT_SYN (0X40228)
 CBAC built 1 sessions:
 dns: 192.168.98.62(1034)=>168.95.1.1(53) state:UDP_CLIENT_SYN (0X40229)
router#

router# debug ip inspect tcp
router# terminal monitor
25:54.237  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
25:54.237 et0/0
25:54.263  CBAC: RCV TCP packet 192.168.99.61:21=>192.168.98.62:1412 serial0/0
25:54.265  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
25:54.265 et0/0
```

```
25:54.379  CBAC: RCV TCP packet 192.168.99.61:21=>192.168.98.62:1412 serial0/0
25:54.569  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
25:54.569 et0/0
25:58.813  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
25:58.813 et0/0
25:58.850  CBAC: RCV TCP packet 192.168.99.61:21=>192.168.98.62:1412 serial0/0
25:58.975  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
25:58.975 et0/0
25:59.714  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
25:59.714 et0/0
25:59.873  CBAC: RCV TCP packet 192.168.99.61:21=>192.168.98.62:1412 serial0/0
26:00.054  CBAC: RCV TCP packet 192.168.99.61:21=>192.168.98.62:1412 serial0/0
26:00.176  CBAC: RCV TCP packet 192.168.98.62:1412=>192.168.99.61:21
fastethern
26:00.176 et0/0
```

router# **debug ip inspect object-creation**

```
27:05.711 INSPECT Object Creations debugging is on
27:14.453  CBAC: creat a session table (0x40230)
27:14.453  CBAC: building a new tcp session
28:37.100  CBAC: creat a session table (0x40231)
28:37.100  CBAC: building a new udp session (0x40231)
28:41.098  CBAC: creat a session table (0x40232)
28:41.098  CBAC: building a new udp session (0x40232)
28:44.123  CBAC: creat a session table (0x40233)
28:44.124  CBAC: building a new udp session (0x40233)
28:48.127  CBAC: creat a session table (0x40234)
28:48.128  CBAC: building a new udp session (0x40234)
28:54.362  CBAC: creat a session table (0x40235)
28:54.362  CBAC: building a new tcp session
router#
```

```
router# debug ip inspect object-deletion
29:33.138 INSPECT Object Deletions debugging is on
```

```
29:37.201  CBAC: delete a session table (40235)
29:40.059  CBAC: delete a session table (40232)
29:45.059  CBAC: delete a session table (40230)
29:58.059  CBAC: delete a host session table
29:58.059  CBAC: delete a session table (40236)
```

5.5 Radius Security (AAA)

AAA (Authentication Authorization Accounting) is the way that allows access to the network server and what services they are allow using once they have access.

radius-server host ip address of radius server **[acc-port | auth-port]** – specify the IP address of the RADIUS server.

radius-server key – specify the key between the access point and RADIUS server

radius-server retransmit – specify the number of times the access point sends the request to server

radius-server timeout – specify the number of seconds that access point waits for a reply to a RADIUS request before resending the request.

Radius-server deadtime – specify the time that mark as “dead” when RADIUS server fail to respond to authentication request.

aaa authentication ppp authentication name **[local | radius]** – specify aaa authentication methods for use on serial interface and running ppp

aaa accounting network name accounting list **start-stop radius** – runs start-stop accounting for all packet service and use radius server.

ppp pap send-username pap username **password** pap password – enable the remote pap support for an interface and send the pap authentication request packets.

ppp authentication [chap | pap] – specify the chap or pap authentication on interface

ppp chap hostname – configure the chap hostname

ppp chap password – configure the chap password

ppp compress [predictor | stacker] – configure predictor or stacker compress on the interface

Configuration Example

PAP example

Router 1

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 St3Yuxw1NBTq
!
aaa authentication ppp scott radius
aaa accounting network scott start-stop radius

username scott password 7 1clZ5Mnm-XEu
!
interface fastethernet 0/0
  ip address 192.168.99.64 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.1 255.255.255.192
  ppp authentication pap scott
  ppp accounting scott
  clockrate 48000
!
interface async 0/0
!
router rip
  network 192.168.99.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 kdWL6UXPkdPV/B
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
radius-server key 7 DRjQtY26F/tc
radius-server deadtime 2
radius-server retransmit 4
```

```
radius-server host 192.168.99.63
!
end

router#
```

Router 2

```
ERT-805> enable
Password:
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 uh4a5s35v9i6
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  ppp pap sent-username scott password 7 ZVnRE6gNg/-O
!
interface async 0/0
!
router rip
  network 10.0.0.0
  network 192.168.98.0
!
line vty 0 4
  login
  password 7 3Z4SNtmYpBT6BC
!
```

```
ip route 0.0.0.0 0.0.0.0 serial 0/0
!
end

ERT-805#
```

CHAP Example

Router 1

```
router# show run
```

Building configuration ...

service password-encryption

service timestamps debug

!

hostname router

!

enable password 7 St3Yuxw1NBTq

!

aaa authentication ppp scott radius

aaa accounting network scott start-stop radius

username scott password 7 1clZ5Mnm-XEu

!

interface fastethernet 0/0

ip address 192.168.99.64 255.255.255.0

!

interface serial 0/0

encapsulation ppp

ip address 10.0.0.1 255.255.255.192

ppp authentication chap scott

ppp accounting scott

clockrate 48000

!

interface async 0/0

!

router rip

network 192.168.99.0

network 10.0.0.0

```
!
line vty 0 4
  login
  password 7 kdWL6UXPkdPV/B
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
radius-server key 7 DRjQtY26F/tc
radius-server deadtime 2
radius-server retransmit 4
radius-server host 192.168.99.63 acct-port 1646 auth-port 1645
!
end

router#
```

Router 2

```
ERT-805> enable
Password:
Password:
ERT-805# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 uh4a5s35v9i6
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  ppp chap hostname scott
  ppp chap password 7 vI3c39uvvCdX
```

```
!
interface async 0/0
!
router rip
  network 10.0.0.0
  network 192.168.98.0
!
line vty 0 4
  login
  password 7 3Z4SNtmYpBT6BC
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
!
end

ERT-805#
```

Debug radius

```
13:51.914 #Line serial0/0 Protocol Up
13:51.921 Radius: Send to 192.168.99.63:1646, Accounting_Request, id 0xfe, len
13:51.921 52
13:51.922        Attribute type: ATTR_USER_NAME, len: 7
13:51.922               value: 73 63 6f 74 74
13:51.923        Attribute type: ATTR_CLASS, len: 6
13:51.923               value: 61 14 6 ae
13:51.923        Attribute type: ATTR_ACCT_STATUS_TYPE, len: 6
13:51.924               value: 0 0 0 1
13:51.924        Attribute type: ATTR_ACCT_SESSION_ID, len: 6
13:51.925               value: 0 0 0 5
13:51.925        Attribute type: ATTR_USER_NAME, len: 7
13:51.925               value: 73 63 6f 74 74
13:51.931 Radius: Received from 192.168.99.63:1646, Accounting_Response, id 0xf
13:51.931 e, len 20
13:51.931 Radius: No attributes in Message
```

Chapter 6 QOS

Quality of service (QOS) is use to improve the network efficiency. ERT-805 provides some different QOS, which are CAR, Policy-based Routing, Weight fair queuing and class-map

6.1 CAR – Committed Access Rate

CAR (Committed Access Rate) is allows user to limit the output transmission rate on an interface. CAR provides two qualities of service functions:

- Ø Bandwidth management through rate limit
- Ø Packet classification through IP precedence

The following example is shows how to configuration CAR:

rate-limit output [access-group] access-list no bps Normal bust number Maximum bust number **conform-action** conform action **exceed-action** exceed action **–** configure CAR and distributed policies.

output	Applies this CAR traffic policy to packets sent on this output interface.
access-group	(Optional) Applies this CAR traffic policy to the specified access list.
bps	Average rate, in bits per second (bps).
Normal burst bytes	Normal burst size, in bytes.
Maximun bust bytes	Excess burst size, in bytes.
conform-action conform-action	• **continue**—Evaluates the other rate-limit • **drop**—Drops the packet. • **transmit**—Sends the packet.
exceed-action exceed-action	• **continue**—Evaluates the other rate-limit . • **drop**—Drops the packet. • **transmit**—Sends the packet.

Violate-action	• **continue –** Evaluates the other rate-limit • **drop –** Drops the packet • **transmit –** Sends

show interface rate-limit – display information about CAR for an interface

Configuration Example

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname ERT-805
!
enable password 7 uh4a5s35v9i6
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  rate-limit output access-group 100 9600 24000 32000 conform-action transmit
exceed-action drop
  rate-limit output access-group 101 8000 24000 32000 conform-action transmit
exceed-action drop
rate-limit output 10000 16000 24000 conform-action transmit exceed-action drop

!
interface async 0/0
!
router rip
  network 10.0.0.0
  network 192.168.98.0
!
line vty 0 4
  login
```

```
  password 7 3Z4SNtmYpBT6BC
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
!
access-list 100 permit tcp any any eq www
access-list 101 permit tcp any any eq ftp
!
end

router#

router# show interface s0/0 rate-limit

  Output
    matches: access-group 100
      params: 9600 bps, 24000 limit, 32000 extended limit
      conformed 3582 packets, 219373 bytes; action: transmit
      exceeded 0 packets, 0 bytes; action: drop
      last packet: 2ms ago, current burst: 23939 bytes
      conformed 2014 bps, exceeded 0 bps
  Output
    matches: access-group 101
      params: 8000 bps, 24000 limit, 32000 extended limit
      conformed 37 packets, 2489 bytes; action: transmit
      exceeded 0 packets, 0 bytes; action: drop
      last packet: 157119ms ago, current burst: 23918 bytes
      conformed 0 bps, exceeded 0 bps
  Output
    matches: all traffic
      params: 10000 bps, 16000 limit, 24000 extended limit
      conformed 2450 packets, 2322667 bytes; action: transmi
      exceeded 22 packets, 33462 bytes; action: drop
      last packet: 1ms ago, current burst: 15939 bytes
      conformed 122 bps, exceeded 0 bps
router#
```

6.2 Policy-based Routing

PBR (policy-based routing) is allows user manually to defined policy that how to received packets should be routed and also allows user to identify packets using several attributes to specify the next hop to which the packet should be sent.

route-map map-name **[deny | permit]** sequence-number – to define the condition for policy routing

match ip address access-list number – to specify the condition by access-list

match length min max – to establish criteria based on packet length.

set ip next-hop ip address for next hop – to specify the next-hop router in path that packets should be forward.

ip policy route-map map name – identify a route map to use for policy routing on an interface.

set interface type of interface – specify a list of interface which the packets can be routed.

traceroute Trace route to destination address - discovers the routes packets follow when traveling to their destinations

Configuration Example

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 wonRBhc01DcE
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation hdlc
  ip address 10.0.0.2 255.0.0.0
  ip policy route-map richard
!
interface async 0/0
!
```

```
router rip
  version 2
  network 10.0.0.0
  network 192.168.98.0
!
line vty 0 4
  login
  password 7 k2CZPVdrqEggyC
!
route-map richard
  match ip address 1
  set interface serial 0/0
  set ip next-hop 10.0.0.1
!
access-list 1 permit 192.168.98.62 0.0.0.255
!
end

router#
```

6.3 Class-map and policy-map

Class-map command is a global command which is for specify a traffic class containing match criteria. This command is used to create traffic class only the traffic policy must use the other command that is policy-map to specify.

The traffic class is associated with traffic policy when the **class** command is used. After entering the **class** command, you are automatically in policy-map class configuration mode, which is where the QoS policies for the traffic policy are defined. The following example is shows how to configure Class-map.

class-map [match-all | match-any] class-map name – specify the traffic class.

- **match-all** – when all of the match criteria in class-map must met for traffic entering that specify in class-map.
- **match-any** – when one of the match criteria in class-map must met for traffic entering that specify in class-map

match access-group access-list no – specify the access-list index

any – match any packets

match input-interface – specify an input interface to match

match class-map class-map name – specify the traffic class as a match criterion.

match ip rtp lower bound of UDP destination prot – configure class-map that use rtp protocol port as match criterion

match protocol ip [tcp | upd] tcp/udp port number – specify the class-map that use two different protocol as match criterion.

policy-map map name – configure the policies for class whose match criteria for a class.

class class-map name – specify the policy criteria

bandwidth [**percent | remaining | 8-2000000]** – specify the bandwidth for a class that belong to a policy map

fair-queue – specify the number of dynamic queues

shape [average | max-buffer | peak] – specify the traffic shaping

queue-limit packets – Specify the maximum number of packets that queue for a traffic class

priority [percent | 8-2000000] – specify the guaranteed allow bandwidth in kilo bits or percent for priority traffic

police [access-group | bps per second *bps burst-normal burst-max* **] conform-action** *action* **exceed-action** *action* **violate-action** action – Specify the maximum bandwidth usage by a traffic class.

show policy-map interface interface – display configuration and statistics of the policy that attached to an interface

show class-map – display all configuration traffic policy

show class-map class-map name – display the information of user-specific traffic policies.

Configuration Example

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
```

```
enable password 7 wonRBhc01DcE
!
class-map match-any test
 match access-group 101
 match protocol ip tcp 80
 match input-interface serial 0/0
!
class-map match-any test1
 match access-group 102
 match protocol ip tcp 80
 match input-interface serial 0/0
!
policy-map richard
 class test
   bandwidth percent 60
   queue-limit 2
  !
 class test1
   bandwidth percent 40
   queue-limit 2
  !
!
interface fastethernet 0/0
 ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
 encapsulation hdlc
 ip address 10.0.0.2 255.0.0.0
 service-policy Richard
!
interface async 0/0
!
router rip
 version 1
 network 192.168.98.0
 network 10.0.0.0
!
line vty 0 4
```

```
 login
 password 7 k2CZPVdrqEggyC
!
ip route 192.168.99.0 255.255.255.0 10.0.0.1
!
access-list 1 permit 192.168.98.62 0.0.0.255
access-list 101 permit ip host 192.168.98.62 any
access-list 102 permit ip host 192.168.98.63 any
!
end
router#


router# show policy-map interface s0/0
serial0/0
  Service-policy output: marc
    Class-map: test (match-any)
      13765 packets, 842504 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 100
      Match: protocol ip tcp  80
      Match: input-interface serial0/0
      Weighted Fair Queueing
        Output Queue: Conversation
        Bandwidth 60 (%)  Max Thresh 2 (packets)
        (pkts matched/bytes matched) 13765/842504
      Traffic Shaping
        Target    Byte      Sustain   Excess    Interval  Increment Adapt
        Rate      Limit     bits/int  bits/int  (ms)      (bytes)   Active
        154400000 4000      154400000 154400000 1000      0         no
        Queue     Packets   Bytes     Packets   Bytes     Shaping
        Depth                         Delayed   Delayed   Active
        0         0         0         0         0         no
    Class-map: test1 (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 101
      Match: input-interface serial0/0
      Match: class-map test
```

```
      Weighted Fair Queueing
        Output Queue: Conversation
        Bandwidth 40 (%)  Max Thresh 2 (packets)
        (pkts matched/bytes matched) 0/0
    Class-map: class-default (match-all)
      137 packets, 8713 bytes
      5 minute offered rate 153 bps, drop rate 0 bps
      Match any
router#
```

```
router# show class-map
 Class Map match-any class-default (id 0)
   Match any

 Class Map match-any test (id 1)
   Match access-group 100
   Match protocol ip tcp  80
   Match input-interface serial0/0

 Class Map match-any test1 (id 2)
   Match access-group 101
   Match input-interface serial0/0
   Match class-map test

router#
```

6.4 Queue

Traffic prioritization is very important for a delay-sensitive, interactive and transaction-based application. Traffic prioritization is most effective on WAN link that combination of busy traffic and relatively lower data rates can cause temporary congestion.

Congestion management feature allow user to control traffic by determining the packets order based on priorities assigned to those packets. Congestion management entails the creation of queues, assignment of packets to those queues based on the classification of the packet, and scheduling of the packets in a queue for transmission. ERT-805 is provides four different types of queue that is FIFO (default in all router), WFQ (Weighed fair queuing), priority queuing and custom queuing.

6.4.1 FIFO- First IN First Out

The traffic for FIFO is transmitted in the order received, without regard bandwidth consumption. In FIFO all packets is treated equally. Packets are sent out an interface in the order. This method is default for all router interfaces.

6.4.2 WFQ – Weighted Fair Queuing

WFQ is an automated method that provides fair bandwidth allocation to all network traffic. WFQ breaks up the train of packets within a conversation to ensure that bandwidth is shared fairly between individual conversations and that low-volume traffic is transferred in a timely fashion

fair-queue congestive-discard-threshold dynamic-queue reservable-queue – configuration an interface to use WFQ

show queueing fair – display status of fair configuration

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 St3Yuxw1NBTq
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  fair-queue 64 128
!
```

```
interface async 0/0
!
router rip
  network 192.168.98.0
  network 10.0.0.0
!
line vty 0 4
  login
  password 7 kdWL6UXPkdPV/B
!
ip route 0.0.0.0 0.0.0.0 serial 0/0
```

```
router# show queueing fair
Current fair queue configuration:
 Interface           Discard        Dynamic        Reserved
                    threshold      queue count    queue count
 serial0/0           64             2              0
```

```
router# show queue s0/0
Weighted Fair Queueing
 Input queue: 0/0/0 (size/max/drops); Total output drops: 0
 Queueing strategy: Weighted Fair Queueing
 Output queue: IP: 10.0.0.2
    0/1000/64/0/1559 (size/max total/threshold/drops/forwards)
    Conversations 1/128 (active/max total)
    Reserved Conversations 0/0 (allocated/max allocated)
router#
```

6.4.3 Priority Queuing

Priority queuing allow user to define the traffic priority in the network. This technique is useful in environment which important traffic should not be delayed by less important traffic.

The following example is how to configuration priority queuing:

priority-list list number **protocol ip [high | medium | normal | low]** queue-keyword – Establish priority queuing based on protocol type

priority-list list number **interface** interface type interface no **[high | medium | normal | low]** – Establish priority queuing for all traffic entering on an incoming interface

priority-list list number **default [high | medium | normal | low] -** Assign the a priority queuing for those packets that doesn't match any other rule in queue

priority-list list number **queue-limit –** specify the maximum number of packets in each queue

Priority Queue Argument	Packet Limits (default)
High	20
Medium	40
Normal	60
Low	80

priority-group list number – Assign priority into interface

show queueing priority – display the status of priority queue list

show interface interface type interface no – displays the detailed queue information

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 Pl2cGlY8liD4
!
interface fastethernet 0/0
 ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
 encapsulation ppp
 ip address 10.0.0.2 255.255.255.192
 ip access-group 100 in
 priority-group 2
!
!
```

```
interface async 0/0
!
router rip
 network 10.0.0.0
 network 192.168.98.0
!
line vty 0 5
 login
 password 7 tF4VZx7eRx5VcC
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1

!
access-list 100 permit tcp host 192.168.99.61 host 192.168.98.62
access-list 100 permit ip any any
priority-list 2 protocol ip high tcp 80
priority-list 2 protocol ip high list 100
priority-list 2 interface fastethernet 0/0 medium
priority-list 2 protocol ip normal
priority-list 2 default low
priority-list 2 queue-limit 15 20 20 30
!
end

router#



router# show queueing priority
Current priority queue configuration:
List    Queue   Args
2       low     default
2       high    protocol ip    tcp           port 80
2       high    protocol ip    list   100
2       medium  interface fastethernet0/0
2       normal  protocol ip
2       high    limit 15
2       medium  limit 20
2       normal  limit 20
```

```
2       low     limit 30
router#

router# show queue s0/0

Priority Queueing, priority-list 2
router#

router# show int s0/0
serial0/0 is administratively up, line protocol is up
 Hardware is RT800-E
 Encapsulation PPP, loopback not set, keepalive set (10 sec)
   LCP Open
   IPCP Open, CCP Closed, CDP Open, MPLSCP Close
 Queueing strategy: priority-list 2
   Output queue: (priority #: size/max/drops/forwards), IP: 10.0.0.2
     high: 0/15/0/508 medium: 0/20/0/814
     normal: 0/20/0/0 low: 0/30/0/0
 5 minute input rate 54 bits/sec, 0 packets/sec
 5 minute output rate 54 bits/sec, 0 packets/sec
    1714 packets input, 1843207 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    1718 packets output, 69301 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 output buffer failures, 0 output buffers swapped out
    1 carrier transitions, 0 internal resets, 0 switch line hook
    software flowcontrol state is none/none (in/out)
    current tx-queue: 0/0/0(nor/exp/sum)
    DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

6.4.4 Custom Queuing

Custom queuing allows user to specify a number of bytes to each queue and each protocol. The following examples are showing how to configure CQ.

PS: Please note that only one queue assign per interface.

queue-list list number **protocol ip** queue-number **queue-keyword** - Establish custom queuing based on protocol type

Queue-keyword	keyword-value	Explain
Fragments	NULL	Any fragments ip packet
List	List-number	Assigns traffic priorities according to a specified list.
Lt	Byte-count	Specifies a less-than count. The priority level assigned goes into effect when a packet size is less than the value entered for the *byte-count* argument.
Gt	Byte-count	Specifies a greater-than count. The priority level assigned goes into effect when a packet size exceeds the value entered for the byte-count argument.
Tcp	Port	Assigns the priority level defined to TCP segments originating from or destined to a specified port.
Udp	Port	Assigns the priority level defined to UDP packets originating from or destined to a specified port.

queue-list list number **interface** interface type interface number **queue number** – Establish priority from a given interface

queue-list list number **default** queue number – Assigns the queue number for those packets that doesn't match any rule in custom queue.

queue-list list number **queue** queue number **limit** limit number – specify the max number of packets allows in each custom queue. The range is start 0 – 1024

queue-list list number **queue** queue number **byte-count** byte-count number – specify the size of bytes per queue.

custom-queue-list list number – Assign custom list to interface

show interface interface type interface number – display the current status of the custom output

show queueing custom - display the status of custom queue list

Configuration Example

```
router# show run
Building configuration ...
service password-encryption
service timestamps debug
!
hostname router
!
enable password 7 Pl2cGlY8liD4
!
interface fastethernet 0/0
  ip address 192.168.98.63 255.255.255.0
!
interface serial 0/0
  encapsulation ppp
  ip address 10.0.0.2 255.255.255.192
  custom-queue-list 10
!
interface async 0/0
!
router rip
  network 10.0.0.0
  network 192.168.98.0
!
line vty 0 5
  login
  password 7 tF4VZx7eRx5VcC
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1
!
access-list 1 permit 192.168.98.62 0.0.0.255
queue-list 10 protocol ip 1 tcp 80
queue-list 10 interface serial 0/0 2
queue-list 10 protocol ip 3
queue-list 10 queue 4 byte-count 115200
queue-list 10 queue 4 limit 10
```

```
queue-list 10 default 5
queue-list 10 protocol ip 1 list 1
!
end

router#

router# show int s0/0
serial0/0 is administratively up, line protocol is up
  Hardware is RT800-E
  Encapsulation PPP, loopback not set, keepalive set (10 sec!
     IPCP Open, CCP Closed, CDP Open, MPLSCP Close
  Queueing strategy: custom-queue-list 2
    Output queues: (queue #: size/max/drops/forwards), IP: 10.0.0.2
      0:0/20/0/58 1:0/20/0/38 2:0/20/0/0 3:0/20/0/1914
      4:0/20/0/0 5:0/20/0/0 6:0/20/0/0 7:0/20/0/0
      8:0/20/0/0 9:0/20/0/0 10:0/20/0/0 11:0/20/0/0
      12:0/20/0/0 13:0/20/0/0 14:0/20/0/0
      15:0/20/0/0 16:0/20/0/0
  5 minute input rate 116 bits/sec, 0 packets/sec
  5 minute output rate 159 bits/sec, 0 packets/sec
     1180 packets input, 1132182 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 fraee, 0 overrun, 0 ignored, 0 abort
     1199 packets output, 51604 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions, 0 internal resets, 0 switch line hook
     software flowcontrol state is none/none (in/out)
     current tx-queue: 0/0/1(nor/exp/sum)
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
     serial port mode is V.24 DTE(0x7e)
router#
```

```
router# show queueing custom
Current custom queue configuration:
List    Queue   Args
10      5       default
10      1       protocol ip    tcp   port 80
10      2       interface serial0/0
10      3       protocol ip
10      1       protocol ip    list 1
10      4       byte-count 115200       limit 10
router#
```

Appendix A Upgrade firmware

Please follow the steps to upgrade firmware:

1. Find and download the latest firmware from PLANET Web site.

2. Connect Console port to ERT-805 Serial WAN Router

3. Change to DPS-mode and run mrcom32.exe (this program can be found in the CD-ROM menu, directory “/utility”)

4. Type mrcom32 com1 115200 (default is 9600)

5. Press Ctrl + Shift + 6 to get into main menu

6. To change Mointor Baud is press 8

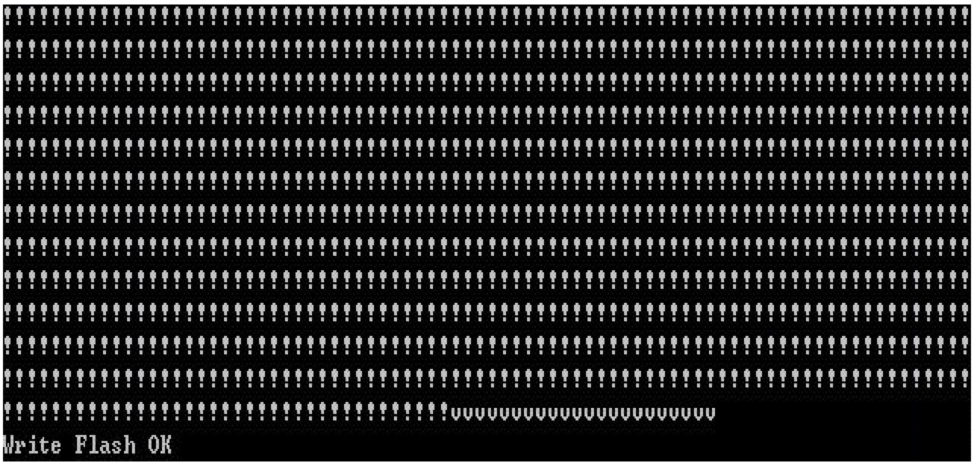
7. Type in 115200 (eg **Input Baud [9600] 115200**) press 15 to save and then press 3 to restart

8. Press Ctrl + End then type in mrcom32 com1 1152000 for example **mrcom32 com1 115200** press enter

9. Then get into main menu again and type 1 press enter

After you press **1** it will shows following screen

Then press enter still see the **Input File Name,** type in the file’s name and press enter again



10. Then press **3** to restart Router

Now, the ERT-805 is with the firmware file just downloaded.

Appendix B Router Dialing

ERT-805 is support dial-up from modem which is allow user to remote to office from other place. And the commands are:

Physical-layer async – configure serial interface as an async interface

async mode [dedicated | interactive] – specify line mode for interface use

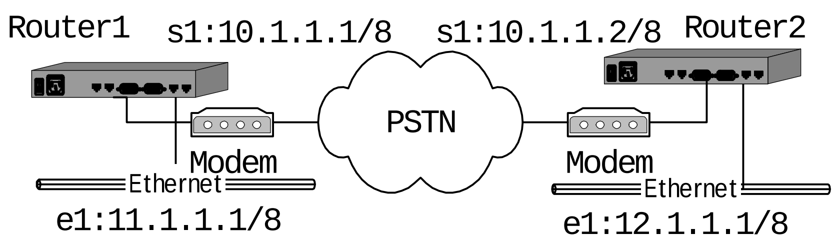
dialer-list list number **protocol ip [deny | list | permit]** – configure DDR to control dialing by protocol

dialer-group – configures an interface belong to a specific dialing group

dialer-inband – enable DDR and V.25 bits dialing on the async interface

dialer string – specify the phone number to dial to a specific destination

Configuration Example



Configuring router Router1

```
int s1
encap ppp
ip address 10.1.1.1 255.0.0.0
physical-layer async
async mode dedicate
line flowcontrol hardware
line cd normal
line speed 9600
dialer in-band
dialer string 2001
dialer-group 1
line inactive-timer 60
```

```
ip  route  12.0.0.0 255.0.0.0 10.1.1.2
dialer- list 1 protocol ip permit
```

Configuring router Router2

```
int s1
encap ppp
ip address 10.1.1.2 255.0.0.0
physical-layer async
async mode dedicate
line flowcontrol hardware
line cd normal
line speed 9600
dialer in-band
line inactive-timer 60
dialer- list 1 protocol ip permit
```

Appendix C Cables / Pin-assignment for ERT-805

C.1 V.35 DTE – CB-ERTV35-MT

Pin to ERT-805	Description		Pin to device	Description
21	MODE_1			
18	MODE_0	GND		
25	MODE_DCE			
1	Shield		A	Shield_GND
08	B_DCD/DCD+	Twisted pair no. 1 <—	F	RLSD
7	GND+		B	GND
03	I_RXD/TXD+	Twisted pair no. 9 <—	R	RD+
16	I_RXD/TXD -	<—	T	RD -
02	O_TXD/RXD+	Twisted pair no. 5 —>	P	SD+
14	O_TXD/RXD -	—>	S	SD -
05	I_CTS/RTS+	Twisted pair no. 2 <—	D	CTS
06	I_DSR/DTR+	<—	E	DSR
04	O_RTS/CTS	Twisted pair no. 4 —>	C	RTS
20	O_DTR/DSR+	—>	H	DTR
17	I_RXC/TXCE+	Twisted pair no. 8 <—	V	SCR+
09	I_RXC/TXCE -	<—	X	SCR -
24	O_TCXE/RXC+	Twisted pair no. 6 —>	U	SCTE+ Not used
11	O_TXCE/RXC -	—>	W	SCTE - Not used
15	B_TXC/TXC+	Twisted pair no. 7 <—	Y	SCT+
12	B_TXC/TXC -	<—	AA	SCT -

C.2 V.35 DCE – CB-ERTV35-FC

Pin to ERT-805	Description		Pin to device	Description
21	MODE_1			
18	MODE_0	GND		
25	MODE_DCE	GND		
1	Shield		A	Shield_GND
08	B_DCD/DCD+	Twisted pair no. 1 <—	F	RLSD
7	GND		B	GND

03	I_RXD/TXD+	Twisted pair no. 3 <—	P	SD+
16	I_RXD/TXD-	<—	S	SD-
02	O_TXD/RXD+	Twisted pair no. 5 —>	R	RD+
14	O_TXD/RXD-	—>	T	RD-
05	I_CTS/RTS+	Twisted pair no. 2 <—	C	RTS
06	I_DSR/DTR+	<—	H	DTR
04	O_RTS/CTS	Twisted pair no. 4 —>	D	CTS
20	O_DTR/DSR+	—>	E	DSR
17	I_RXC/TXCE+	Twisted pair no. 8 <—	U	SCTE+ Not used
09	I_RXC/TXCE-	<—	W	SCTE- Not used
24	O_TCXE/RXC+	Twisted pair no. 6 —>	V	SCR+
11	O_TXCE/RXC-	—>	X	SCR-
15	B_TXC/TXC+	Twisted pair no. 7 —>	Y	SCT+
12	B_TXC/TXC-	—>	AA	SCT-

C.3 V.24 DTE – CB-ERT232-MT

Pin to ERT-805	Description		Pin to device	Description
21	MODE_1			
18	MODE_0			
25	MODE_DCE			
1	Shield		1	Shield_GND
08	B_DCD/DCD+	Twisted pair no. 1 <—	8	CD
7	GND		7	GND
03	I_RXD/TXD+	Twisted pair no. 3 <—	3	RXD
16	GND			GND
02	O_TXD/RXD+	Twisted pair no. 5 —>	2	TXD
14	GND			GND
05	I_CTS/RTS+	Twisted pair no. 2 <—	5	CTS
06	I_DSR/DTR+	<—	6	DSR
04	O_RTS/CTS	Twisted pair no. 4 —>	4	RTS
20	O_DTR/DSR+	—>	20	DTR
17	I_RXC/TXCE+	Twisted pair no. 8 <—	17	RXC
09	GND	GND		GND
24	O_TCXE/RXC+	Twisted pair no. 6 —>	24	TXCE Not used
11	GND	—>		GND
15	B_TXC/TXC+	Twisted pair no. 7 <—	15	TXC

12	GND			GND

C.4 V.24 DCE – CB-ERT232-FC

Pin to ERT-805	Description		Pin to device	Description
21	MODE_1			
18	MODE_0			
25	MODE_DCE	GND		
1	Shield		1	Shield_GND
08	B_DCD/DCD+	Twisted pair no. 1 —>	8	CD
7	GND		7	GND
03	I_RXD/TXD+	Twisted pair no. 3 <—	2	TXD
16	GND			GND
02	O_TXD/RXD+	Twisted pair no. 5 —>	3	RXD
14	GND			GND
05	I_CTS/RTS+	Twisted pair no. 2 <—	4	RTS
06	I_DSR/DTR+	<—	20	DTR
04	O_RTS/CTS	Twisted pair no. 4 —>	5	CTS
20	O_DTR/DSR+	—>	6	DSR
17	I_RXC/TXCE+	Twisted pair no. 8 <—	24	TXCE Not used
09	GND	GND		GND
24	O_TCXE/RXC+	Twisted pair no. 6 —>	17	RXC
11	GND	—>		GND
15	B_TXC/TXC+	Twisted pair no. 7 —>	15	TXC
12	GND			GND

C.5 X.21 DTE – CB-ERTX21-MT

Pin to ERT-805	Description		Pin to device	Description
21	MODE_1	GND		
18	MODE_0			
25	MODE_DCE			
1	Shield		1	Shield_GND
7	GND		8	GND
03	I_RXD/TXD+	Twisted pair no. 3 <—	4	RXD+
16	I_RXD/TXD-		11	RXD-
02	O_TXD/RXD+	Twisted pair no. 5 —>	2	TXD+

14	O_TXD/RXD-		9	TXD-
05	I_CTS/RTS+	Twisted pair no. 2 <—	5	INDICATION+
06	I_DSR/DTR+	<—	12	INDICATION-
04	O_RTS/CTS	Twisted pair no. 4 —>	3	CONTROL+
20	O_DTR/DSR+	—>	10	CONTROL-
17	I_RXC/TXCE+	Twisted pair no. 8 <—	6	TIMING+
09	I_RXC/TXCE-	<-	13	TIMING-
		Twisted pair no. 6 —>		
		—>		
		Twisted pair no. 7 —>		

C.6 X.21 DCE – CB-ERTX21-FC

Pin to ERT-805	Description		Pin to device	Description
21	MODE_1	GND		
18	MODE_0			
25	MODE_DCE	GND		
1	Shield		1	Shield_GND
7	GND		8	GND
03	I_RXD/TXD+	Twisted pair no. 3 <—	2	TXD+
16	I_RXD/TXD-		9	TXD-
02	O_TXD/RXD+	Twisted pair no. 5 —>	4	RXD+
14	O_TXD/RXD-		11	RXD-
05	I_CTS/RTS+	Twisted pair no. 2 <—	3	CONTROL+
06	I_DSR/DTR+	<—	10	CONTROL-
04	O_RTS/CTS	Twisted pair no. 4 —>	5	INDICATION+
20	O_DTR/DSR+	—>	12	INDICATION-
24	O_TCXE/RXC+	Twisted pair no. 8 —>	6	TIMING+
11	O_TXCE/RXC –	—>	13	TIMING-
		Twisted pair no. 6 —>		
		—>		
		Twisted pair no. 7 —>		

C.7 RJ-45 Console Cable

The ping out of the RJ-45 console cable bundled in the package is as following:

1..8

2..7

3..6

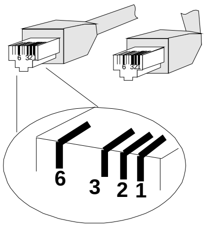
4..5

5..4

6..3

7..2

8..1



C.8 DB9 to RJ45

The pin out of the DB9 to RJ-45 accessory bundled together with the package are as following.

DB9	RJ45
1	4
2	6
3	3
4	2
5	5
6	7
7	1
8	8